A MANUAL OF HYGIENE

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PREFACE.

THIS book has been written as the result of the author's experience in the class-room of the need of a concise text-book on Hygiene adapted to American conditions. It is not offered as a substitute for the many elaborate treatises on the subject, the study of which it earnestly aims to encourage.

It is believed, however, that much valuable time might be saved both to the lecturer and to the student by the use of a text-book embodying in concise form the fundamental principles of hygiene and preventive medicine, and that such time might be more profitably used for wider discussion of the subject in the lecture-room, and practical demonstration and study in the laboratory and elsewhere of the problems involved.

While the methods of laboratory examinations in various subjects have been indicated, no attempt has been made to make this a handbook of laboratory practice in hygiene. It is believed that the course in hygiene in most of our medical schools does not at present permit of this, and that the addition of any adequate technical discussion of laboratory work would convert this book into an unwieldy volume, without adding to its immediate usefulness to the under-

graduate student. A manual of laboratory practice in hygiene might well constitute a separate volume.

It is hoped that in addition to medical students, for whom it was primarily written, this book may also be found useful for students in higher schools and colleges, who, as the future guardians of public health, need definite scientific instruction in the principles of hygiene.

The writer would acknowledge her obligations to the various works of European and American authorities, which she has freely consulted in the preparation of this book. Thanks are also due to the experts who have kindly given valuable counsel and criticism on various subjects requiring special knowledge and experience.

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TABLE OF CONTENTS.

CHAPTER IV.

CLIMATE.

CHAPTER V.

THE SOIL AS RELATED TO HEALTH.

CHAPTER VI.

WATER.

CHAPTER VII.

FOOD.

CHAPTER VIII.

THE DWELLING.

CHAPTER IX.

Ventilation and Heating.

CHAPTER X.

Household Disposal of Garbage and Excreta.

CHAPTER XI.

The Final Disposal of Sewage and Refuse in Communities.

CHAPTER XII.

Growth and Development.

CHAPTER XIII.

Exercise.

CHAPTER XIV.

Individual Hygiene.

CHAPTER XV.

Clothing.

CHAPTER XVI.

Baths.

CHAPTER XVII.

School Hygiene.

CHAPTER XVIII.

Infectious Diseases: Their Cause and Prevention.

CHAPTER XIX.

Disinfection—Isolation—Quarantine.

CHAPTER XX.

LIST OF ILLUSTRATIONS.

A MANUAL OF HYGIENE.

CHAPTER I.

Public Health and Preventable Disease.

Hygiene may be defined as the art of preserving health. In its most liberal sense, it concerns itself with the development and culture of both mind and body.

In earlier times its methods for securing these ends have lacked the precision which modern science is now able to lend it in many directions. This was necessarily the case so long as the contributions of modern physiology, pathology and bacteriology were practically unknown to science. The increased knowledge of the functions of the human body which we owe to modern physiology, affords a more exact basis for the formulation of rules which shall further the Maintenance of Health: and this may be considered as the first great province of hygiene.

The brilliant contributions of pathology and bacteriology to our knowledge of the cause of a large class of the devastating diseases of mankind, constitute an additional and precise basis for the exercise of the second great province of hygiene, which is the Prevention of Disease.

While we owe much of the definiteness of its present methods to modern investigations, hygiene boasts a history as old as the time of Moses, whose sanitary code

was very explicit in its rules for personal, domestic and camp hygiene, as understood at that time. Personal cleanliness, the destruction of infectious clothing by fire, the disinfection of houses by lime, and even their burning, the isolation of the leper, and many other ceremonial observances, were practical conceptions of hygiene which were of untold benefit to the Jews, and unquestionably bore their fruit in the comparative immunity of that nation from epidemics at that time, and for long periods thereafter.

Even in the days of Homer we hear of the disinfecting powers of sulphur fires; and the personal hygiene of the Greek was calculated to maintain the health of the healthy at a high standard, although as a nation they had little pity or help for the delicate, the sickly, or the deformed. The Romans clearly recognized the value of pure water and drainage of soils, as archæology has given proof; and recent investigations have shown that a wise foresight animated them when they built their magnificent aqueducts and planned their elaborate system of subsoil drainage; while their military hygiene, as shown by the mortality from preventable disease in their campaigns, compares favorably with English camp history, or with our own dark chapters of the Civil War.

Still, there was little exact knowledge in these days of the causation of disease, which must always be the basis of prevention; and with all the light that history can throw on the picture, the fact remains that the

waste of life by preventable disease is one of the most startling features in the history of the race.

We hear of an epidemic in the time of Justinian which lasted practically fifty years with only slight and unimportant intermissions. The story of the plague in Europe is gloomy beyond expression. China at that time counted its dead by millions. Italy lost one-half of its population; the city of London buried over 100,000 people, and was only released from the plague by the equally devastating flames; while 1,000 grave-diggers in Constantinople, constantly occupied, were not sufficient to bury the victims of this scourge.

It is estimated that in three years time over twenty-five million human beings perished from the face of the earth, and the moral convulsions that followed as a consequence of such a reign of terror were scarcely less important in their influence upon the world.

The history of military campaigns offers us one of the most striking instances of the needless sacrifice of human life. It is a well-known fact that the loss to an army by the sword is small compared with that from sickness. It is said that during the French Revolution the English army lost in war twenty thousand men, but by mortality from sickness (most of the complaints coming under the head of preventable diseases) three times as many perished, while the number of men who were constantly on the sick list was ten times as great.

In our own Civil War the ninety-seven thousand men who died from the direct effects of their wounds, yielded their lives a willing and necessary sacrifice in camp or on the battle-field to the cause for which they fought; but beside those who fell on the battle-field there was another unfortunate contingent in the ranks, nearly twice that number (184,000) who perished during those four years the victims of preventable sickness, traceable directly to foul air, bad drainage, polluted water, imperfect quarantine, and other unsanitary conditions within the power of human beings to control.

The prevalence and mortality of the zymotic diseases — scarlet-fever, diphtheria, measles, etc. — in America and Europe, constitute them the great dreaded scourges of childhood. It is estimated from the records of the London Fever Hospital that about six hundred thousand cases of these diseases, which are perfectly well understood to be preventable, occur in that country every year. The imagination can scarcely picture the amount of misery included in such numbers, involving as it does not only immediate suffering, but also lessened usefulness, and often destitution for the entire household concerned.

The enormous mortality among infants is a blot upon the civilized world, since it is due in the majority of cases to preventable conditions.

In North America it is estimated that from one-fourth to one-third of all the deaths in a community

occur among children under one year of age; and in New York alone, during the summer months, fifty per cent. of the deaths occur among babies of this age. By far the larger proportion of these deaths are directly traceable to improper conditions of food and drink which a better knowledge of hygiene would correct.

The entire subject has, however, not only its moral but its financial aspect, since preventable illness is not only a waste of life, but can be shown to be a waste of money as well.

An interesting example of this was published by Dr. Benjamin Lee, of Philadelphia, after a severe epidemic of small-pox which befell that city in 1891–2. Dr. Lee estimates, on one side, the expenditure of the Philadelphia Board of Health under their policy of concealing the condition of the city. He considers the loss to travel and traffic on railroads, the loss to hotel keepers, merchants and manufacturers from diminished patronage. He adds to these the cost of the care of the sick, the loss of time to them and to the State through their disability, and the expense of burial. Under these estimates the total cost of the epidemic was only a trifle less than *twenty-two millions of dollars.*

Dr. Lee then gives a similar estimate of what might have been the expenditure under a policy of preventive measures. This would have necessitated the establishment of a Vaccine Bureau, with a large force

of physicians for vaccinating the public, a disinfecting station, with all its details, and the publication and distribution of pamphlets of instruction to the public.

Under such measures of prevention hospital expenses would be reduced, as fewer patients would be ill; the consequent loss by sickness, disability and death would be less; while, with the public confidence engendered by a wise and frank policy of this nature, the loss to travel and traffic was estimated as zero.

The sum total of this estimate leaves a balance to the credit of sanitation of over twenty-one million dollars. In other words, the epidemic actually cost the city of Philadelphia about twenty-two million dollars; while a policy of prevention, estimated in these details, would have cost about seven hundred thousand dollars.

There is, however, a brighter side to this picture, and one which offers us an encouraging basis for future work. This is to be found in the beneficent influence of civilization and the achievements of science during the past century, which have unquestionably lengthened the duration of life and abated some, at least, of its scourges.

It is said that in the sixteenth century the average duration of life was about 21¼ years. In the nineteenth century the same statistics give 40½ years as the average period. Records of life insurance com-

panies show that the expectation of human life has been increased 25 per cent. since the seventeenth century. The mortality of infants has decreased, by the same statistics, from 25 per cent. to 15 per cent. of children under one year; and this saving of life in the household, as well as in our foundling and other asylums, is directly traceable to attention to hygienic measures as regards proper diet and pure air.

The discovery and universal practice of vaccination can be shown to have saved hundreds of thousands of lives annually throughout the civilized earth, whereas a century ago one-tenth of all the people of the globe perished from small-pox, and nearly twice as many were permanently disfigured by its ravages. Some of the other great scourges of history have been limited, if not exterminated, by hygienic measures solely. This is notably true of leprosy and scurvy. Leprosy in the thirteenth century was as common as measles; but now, thanks to the sanitary principle of isolation, it is unknown in most of the civilized communities.

Scurvy, two hundred years ago, is said to have caused more deaths in the British navy than all those from battle, wreck and accident put together. But the knowledge that this disease is due to a deprivation of vegetable and fruit diet, and the introduction by Captain Blake of lime-juice into the dietary of the army and navy, has practically abolished the disease among

the military, with an immense saving of life as the result.*

An instance of the value of preventive medicine is found in Russia. Some years ago, under the old system of treating cholera, the annual loss of life in St. Petersburg amounted to from 23,000 to 25,000 persons. Referring to this fact, a well-known English sanitarian characterized the preventive treatment of the premonitory symptoms introduced by the English Board of Health as the most brilliant sanitary service ever rendered, since such treatment resulted in a saving of more than 60,000 lives to the English army. He aptly remarks that a similar loss inflicted on the enemy in battle would have received the enthusiastic official recognition of the Government, but for this really greater service to mankind there was none.

It is impossible to estimate what a saving of life will result in the future from Koch's discovery of the cause of tuberculosis, which has already shown us the definite path which prevention must follow, and will certainly lead to further untold benefits to mankind. Similar inestimable results attend the discovery of the cause of typhoid fever and of cholera.

Isolation in the household and quarantine by gov-

* Investigations lately made into the inhuman treatment of patients in Insane Asylums of New York City show that this perfectly preventable disease has been frequent in at least one of these asylums, where the patients had had practically no vegetables or fruit in their dietary.

In the light of our definite knowledge of the cause of scurvy such a fact is an inexcusable instance of preventable sickness.

ernment have saved thousands of lives to the world; while the method of antisepsis in surgery is one of the great contributions of modern times to preventive medicine.

When all is said, however, it is only too evident that the work of preventive medicine has only begun, and that it is the duty of the physician to further its high aims in every possible direction, both by personal effort and by co-operating with official Boards of Health and other sanitary associations in extending the knowledge of the laws of health, and of the methods of preventing disease.

The personal work of the physician in enforcing these and in acting as a medium of communication of knowledge in his house-to-house visitations, is extremely important.

Nearly fourteen thousand persons died of phthisis in New York State in 1890, and about the same number in 1891.

It is undoubtedly true that a large proportion, if not all, of the cases which will undoubtedly result by infection from these persons, might have been prevented had the scientific facts regarding the spread and prevention of this disease been carefully explained by the physician in charge to the families in which these deaths occurred.

Similar opportunities for the prevention of infant mortality, and for giving advice regarding many other subjects connected with the physical and moral educa-

tion of the young, should be seized by the family physician.

But as personal influence is limited, this should be extended by membership in local sanitary associations, where these exist, and by efforts to form these or local Boards of Health where they do not exist. The function of such boards is that of sanitary police, with full authority in matters of local or State hygiene.

They should also act as educators of the public, by the publication and dissemination of information concerning matters of public health. Certain State Boards of Health have contributed greatly to the scientific investigation of sanitary problems, notably that of Massachusetts, in the study of public water supplies, of Michigan, and others.

The recent action of the Michigan Board of Health, which was immediately followed by that of New York City, in regard to measures for the information of the public concerning the spread and prevention of tuberculosis, and also the work of the New York City Board of Health in the diagnosis of diphtheria by bacteriological analysis in the laboratory, are instances of educational and scientific work in two most important directions effected by State and local health organizations.

In order that the conditions which affect the health or disease of a community may be properly estimated, Boards of Health require the registration of various

statistics and records concerning the sick; and the accumulation of such data forms the basis of Vital Statistics. Every physician can further scientific investigation by making these returns when called for.

Boards of Health, however, are not maintained in their proper efficiency in every State, while in many towns they do not exist at all.

Moreover, conflict between such State Boards as to questions of sanitation which concern the safety of the nation at large are very possible, but would be highly detrimental to the public in times of emergency. In times of epidemics it has become very evident that the safety of the nation required an uniformity and promptness of action incompatible with the independent and often conflicting interests of widely distant State Boards. This is particularly the case in a country like America to whose shores several hundred thousand immigrants come every year, bringing with them, owing to their ignorance and filthy condition, numerous possibilities of disease, unless stringent measures of defense as exemplified in a vigorous quarantine be employed. The conditions of an epidemic have from time to time made the irregular defenses of our country in this respect only too apparent.

These occasions have given rise to the opinion that some National system of supervision of the sanitary condition of the country should be introduced here as it has been abroad, which, without doing away with

State authority, should be free to render advice and assistance to the country at large in times of emergency, and should at all times be a medium of communication between different States for diffusing sanitary knowledge, and stimulating local sanitation.

The general scope of such a Bureau in the United States is indicated in the first section of a bill formulated by the New York Academy of Medicine (Jan., 1894), and now awaiting the action of Congress:

"That the duties of the Bureau of Public Health shall be to collect and diffuse information upon matters affecting the public health, including statistics of sickness and mortality in the several States; the investigation by experimental and other methods of the causes and means of prevention of disease; the collection of information with regard to the prevalence of contagious and epidemic diseases both in this and other countries; the publication of the information thus obtained in a weekly bulletin; the preparation of rules and regulations for securing the best sanitary condition of vessels from foreign ports, and for the prevention of the introduction of infectious diseases into the United States, and their spread from one State into another, which rules when approved by the President of the United States shall have the force of law; the ascertaining by a suitable system of inspection that these rules and regulations are properly carried out and enforced; the advising and informing the several departments of the government, and executives and health authorities

of the several States, on such questions as may be submitted by them to it; or whenever, in the opinion of the Bureau, such advice and information may tend to the preservation and improvement of the public health; and, in general, be the agent of the general government in taking such action as will most effectually protect and promote the health of the people of the United States."

CHAPTER II.

MICRO-ORGANISMS.

The important rôle which micro-organisms play in nature, both beneficent and harmful, their direct relation to certain diseases, and their very wide distribution in the earth, make it essential that we should know the principal facts in the life history of these influential beings.

Classification, Structure, etc.—There are three general classes of micro-organisms, known as *bacteria*, *yeasts* and *moulds*. They are mainly classified according to their method of reproduction. The class which concerns our subject is that of the Bacteria. Bacteria are plants which belong to the lowest order of the vegetable kingdom, closely related to the algæ. They are transparent cells, lacking, for the most part, chlorophyl, and are therefore unable to take up and appropriate carbon for their use as do higher plants. The bacteria are called *fission-fungi*, from their method of multiplying by division. Like higher orders of plants, however, bacteria grow and develop and generate their kind. They are widely distributed in the earth, air and water, and are particularly numerous in the habitations of men, on food, on the skin and

clothing, in the mouth, nose, lungs and gastro-intestinal canal of men and animals.

Some bacteria are capable of producing coloring material of various kinds in the nutrient media. Some have the quality of phosphorescence.

In regard to *shape*, they are found in three forms, viz.: First, the spheroidal or egg-shaped bacterium, called *micrococcus*; second, the rod-shaped, called *bacillus;* and third, the spiral-shaped, called *spirillum.* Some of the micrococci tend to cling together in pairs *diplococcus*, or form little chains, which are called *streptococci.*

In *size* they are extremely minute. Fifteen hundred of them put end to end would scarcely reach across the head of an ordinary pin.

They are composed of granular protoplasm inclosed in a membrane or cell wall. Some of the bacteria have the power of spontaneous movement and under the microscope can be seen rolling and darting about. These movements are effected by means of tiny prolongations they possess, called flagella (whipping threads). Figure 1 shows the three principal forms of bacteria, the appearance of a spore-bearing bacillus, and of the delicate flagella or whipping threads referred to.

The conditions necessary for their life in general are warmth, moisture, oxygen and a certain amount of organic matter. This organic matter they may find everywhere in nature—in the débris from animals and

plants, in the earth, air and water. Oxygen is required in greater or less abundance according to their class. Those which grow and flourish in the presence of oxygen are called ærobic; those which can flourish without oxygen are known as anærobic. Many bacteria can, however, if necessary grow under either condition, *i.e.* with or without oxygen.

By far the larger proportion of bacteria are harmless. Those which induce disease are known as pathogenic.

FIG. I.—FORMS OF BACTERIA.

Micrococci.	Bacilli.	Spirilla.
Single and in chains.	With and without spores.	With and without flagella.

Bacteria are also classified as *saphrophytes* and *parasites:* the former class including such as live entirely on dead organic matter and exist only in the earth, air, etc., the parasites referring to those which always live on other living organisms. The majority of bacteria are saphrophytes. There are also "*semi-saphrophytic*" and "*semi parasitic*" bacteria; *i.e.* those which while generally existing within an animal body can yet maintain a separate existence for a while

external to it; or conversely, those which generally exist external to it and yet are able to maintain themselves for a while within the body of an animal. The term *obligatory* is used for parasites which can only live as such, *facultative* for such as can exist in either way.

The majority of bacteria thrive best at the ordinary temperature of a room or of the summer months, viz., 24° C. (68° F.). Most of the pathogenic bacteria develop best at 35–40° C. (85–102° F.); the bacillus tuberculosis, for instance, thrives best at a temperature of 37° C., which temperature must be constant for its growth. Cold is unfavorable to their activities. Many are killed by a freezing temperature, but experiments have shown that many bacteria will resist for long periods the action of extreme cold; among these is the typhoid bacillus. Repeated freezings and thawings are shown to be most harmful to them. *Light*, especially sunlight, kills after a time most of the pathogenic bacteria; and most are killed by a temperature of boiling water maintained for ten minutes.

Reproduction. Bacteria reproduce by (1) fission and by (2) spores. In the first process the membrane is seen to push inward and across the bacterium, making a partition which divides it into two. These two new germs may again speedily divide, and this process is practically continuous so long as the conditions are favorable. This fission is generally in one direction, occasionally in two places at right angles, forming the so-called tetrad groups, sometimes in three divisions of

space, forming the cubical or bale-like packets known as sarcinæ. So rapid is this multiplication that it has been computed that a rod-like bacillus $\frac{1}{1000}$ of an inch long, might, if it could secure for itself favorable conditions, in five days multiply into a mass equal to all the oceans of the earth if one mile deep. But as a matter of fact these favorable conditions do not exist; lack of food or other untoward circumstances terminating their career before this is possible.

The second method by which bacteria are able to propagate is that of sporulation, and this curious phenomenon has been actually observed in process in several species. In this process the cell-contents are seen to concentrate at certain points which appear more strongly refracting. The fully formed spore then appears as a strongly refracting spheroidal or ovoid body of sharp outline. One cell forms only one spore.

The spore has the capacity of great resistance to unfavorable conditions; and to the spore is due the resistance of many bacteria to highly adverse conditions, such as freezing, boiling, drying, action of chemicals, etc. The ordinary sporeless bacteria are killed by dry heat at a temperature of 100° C. if long continued, and many by a still lower temperature; but spores may be exposed to a dry heat at 140° C. without destruction, although a lower temperature prolonged for some time may destroy their vitality. This resistance to unfavorable conditions is attributed to the stout, firm membrane which surrounds the spore. The

great resistance of the spore membrane explains why certain bacteria have not been uniformly destroyed by disinfection.

Rôle in Nature. As already said, the functions of bacteria in the world are for the most part highly beneficent. They are the agents by which the old and worn-out organic compounds are torn apart and their integral elements returned to nature. The supply of organic matter in the world is limited: therefore, when organic compounds die, they would subtract by so much from the world's supply of oxygen, nitrogen, carbon and hydrogen, if there were no process by which these elements could once more be set free to perform their part again in new combinations.

Bacteria are the agencies by which such a reduction of these compounds to their original elements is effected. When bacteria find such dead organic matter they attack it, tear it apart, and while using an infinitesimal portion for their own nourishment, return by far the largest share of the nitrogen, oxygen, hydrogen and carbon to nature, whence it once more becomes a part of organized life. In the process of putrefaction, which is attended by the evolution of certain gases, ammonia, sulphuretted hydrogen, etc., bacteria are also the active agents.

Similar processes are constantly going on in the soil where the bacteria are extremely numerous, and where they find shreds of leaves, plants, and other less cleanly organic débris, which they in like manner tear

apart and reduce to simpler elements. All organic compounds consist largely of nitrogen in combination. Nitric compounds being torn apart by the soil-bacteria enter into various combinations with different bases found in the soil and form nitrates, while nitrous compounds in the same way form nitrites. In the soil, this process is called nitrifaction and nitration.

Some forms of *fermentation* are also caused by the action of bacteria. Genuine alcoholic fermentation is not indeed due to bacteria proper, but to the beer-making micro-organisms which are nearly allied to them, and which form one of the series of colorless plants; but certain other forms of fermentation, such as the lactic acid fermentation of milk and the butyric acid, etc., found in the intestinal canal, are caused by the action of bacteria proper.

To hygienists, bacteria are of special interest because they cause disease in human beings. While the majority of bacteria are harmless, and live upon the organic matter of the external world, there is a limited number, as already said, which exist at their best only in the human body, where they cause certain diseases. Instances of bacterial diseases are tuberculosis, cholera, typhoid fever.

The full explanation of the phenomena attending their activity in the human body is not yet possible. It is known that they there set free certain compounds which are called tox-albumens, which are

extremely poisonous in their effect upon the body. These compounds are similar to vegetable alkaloids, and are of complicated constitution.

Micro-organisms obtain entrance into the human body through various channels. 1. *The Lungs.* They may be taken in with the air through the nose or mouth, and so pass into the lungs. This is the principal means of infection in tuberculosis. 2. *The Stomach.* They may be swallowed on food or in water or other liquids, and so pass into the stomach. Asiatic cholera is contracted in this manner. 3. *The Skin.* They may enter through wounds or abrasions of the skin, either dropping directly from infected air, or being introduced by contact of the abraided surface with infected hands, clothing or other unclean articles. Various surgical diseases, as pyæmia, are contracted in this way.

Further reference to these modes of entrance, as well as means of protection, will be found under the special chapters on Air, Water, Food, etc., and also on Infectious Diseases.

Examination of Bacteria. Bacteria are studied in the laboratory by cultivating them in different nutrient media and examining them under the microscope. The details of the technic will not be given here; the general method is as follows:

Some nutrient media is used for cultivating them, either fluid or solid. Solid media, such as potato, gelatin or agar-agar is preferred, because of the

greater facility it offers in obtaining pure cultures of the bacteria.

Having cultivated the bacteria on some of these media in order to ascertain their habits of growth, they are further studied under the microscope with high powers, to ascertain their form and activity, etc.

CHAPTER III.

AIR.

Air is a mechanical mixture of oxygen and nitrogen with carbonic acid and watery vapor. The first two of these gases are the essential elements of the atmosphere, the others are accessory, although in all ordinary atmospheres they are present in variable amounts. Oxygen is the important element of the atmosphere, being the one gas without which life and respiration are impossible. Nitrogen is an indifferent element, merely playing the part of a diluent to the oxygen. Carbonic acid is not essential to man, and when present in the usual amounts is an indifferent gas. It is, however, absolutely essential to the vegetable world, which depends upon it for existence, and therefore may be considered an integral part of the atmosphere. Water in the form of vapor varies in amount with the temperature, and is not dependent in any way upon the quantity of other elements present.

In addition to the gaseous constituents, air generally contains floating organic matter, dead and living, as well as various mineral impurities, all forming the dust of the atmosphere, which is unfortunately constantly present in most inhabited regions.

Statistics prove that impure air is one of the largest factors in the mortality of a population, which, both in the case of human beings and among lower animals, is invariably greater in confined and dusty spaces where the air is befouled with the products of respiration and other impurities. Density of population favors poverty and dirt, which in turn favor the increase of organic impurities in the atmosphere. Dr. Farr, late Registrar-General in England, drew attention to the law that the mean duration of life decreased as the proximity of one individual to another increased.

Proximity.	*Mean Duration.*
147 yards	51 years.
139 "	45 "
97 "	40 "
46 "	35 "
28 "	32 "
17 "	29 "
7 "	26 "

The comparative death-rate of males and females in town and country from such diseases as are carried in dusty air, as phthisis, has been found to vary directly with their indoor (polluted air) or outdoor employment.

Similar results have been obtained in the case of lower animals. Cows which are housed in winter have phthisis more than horses whose life is out-of-doors, although it is true that certain features in the lives of the former predispose them to this disease. Horses in army life, both in France and England,

showed at one time so high a rate of mortality (in France, 180–197 per thousand annually), that investigations were made which indicated the cause to lie in the dampness, uncleanliness and bad ventilation of their stables. Improvements, particularly in respect of providing pure air, being established, the mortality fell in ten years to 68 per thousand, and later, under continued improvements, to 27½ per thousand, or a reduction of 75 per cent.

The composition of air by volume is as follows:

Oxygen,	20.96 per 100
Nitrogen,	79.00 per 100
Carbonic dioxide,	.03 per 100
Ammonia,	Trace
Ozone, organic matter, mineral substances,	Variable

Watery vapor, varies with the temperature from .5 grain to 20 grains per cubic foot in a temperate climate.

The air of open spaces is liable to very little change as regards its chief constituents.

Oxygen. The amount of oxygen in pure mountain air is 20.9 per 100, while in the air of towns this may fall to 20.8. In still more confined spaces, as the backs of houses, it is 20.7, and in mines is lowered to 18.

The absolute necessity for this gas, and its qualities as a supporter of combustion and of vital energy, are well known. Its variations in the atmosphere appear to be too slight to be of hygienic importance.

Ozone. Ozone is allotropic oxygen. It is a colorless gas with a peculiar pungent odor. It appears in

the atmosphere after electrical storms, and may also be obtained by the evaporation and electrolysis of water, as well as by any oxidation processes, and in the processes of decay and fermentation. It is only present in the amount of one part in 10,000. It is of less interest from its quantity than from its energetic effects. As it is almost never found in the air of great cities (Paris, London, Boston, etc.) nor in dwelling-houses, it is evidently not a necessity for life.

The effect of breathing an atmosphere containing considerable ozone is difficulty of respiration; and laryngeal spasm with bloody sputa may follow. Ozone is of indirect hygienic importance, because it is deadly to micro-organisms, moulds, etc. It is believed to be generally present at the sea-shore.

Nitrogen has already been referred to as useful simply as a diluent to oxygen, which living beings could not support in a pure state. It has no other hygienic interest. It is incapable of sustaining life, and causes death by suffocation. Gases largely composed of nitrogen occur in disused shafts and also in explosions from rocks, and may also arise from the destruction of coal and organic débris.

Carbonic Acid. The principal sources of carbonic acid in the atmosphere are: First, the respiration of living beings; second, activity of the vegetable world which absorbs it from the atmosphere in the daytime, but gives it off at night; third, the decomposition of organic matter which is always attended with the evo-

lution of this gas; and fourth, combustion. It is estimated that in the city of Manchester alone 15,066 tons are daily poured into the air. Eight hundred and twenty-two million cubic feet are generated in London per day. The total yearly amount generated from combustion and the industrial activities of men is estimated at about 300 million cubic metres.

Flügge estimates that,

Man gives out	22	litres	hourly	of carbonic	acid.
School child gives out	10	"	"	"	"
Petroleum lamp gives out	60	"	"	"	"
Gas flame gives out	100	"	"	"	"

Less carbonic acid is given off during sleep.

Food increases the amount, varying with its nature.

Age increases the amount up to 30 years,—after 45, less.

Sex, males after eight years excrete about one-third more.

Muscular exercise greatly increases the amount given off.

Temperature. More in warm weather, in spring and in the middle of the day — less in cold weather, in autumn and at midnight.

Children excrete relatively twice as much as adults.

Development. More excreted by vigorous than by slender people, and more according to muscular development than by mere size.

Rain diffuses it.

It is extremely diffusable, and easily got rid of by

opening windows, etc., in which it differs from the organic matter of the air. Human beings give off more carbonic acid in the daytime than at night, while plants absorb carbonic acid in the daytime and give it off at night.

The enormous amounts generated by combustion and given off by living beings would be alarming were not the balance maintained by the activities of nature which keep the proportion normal.

The vegetable world, as already explained, absorbs carbonic acid in the daytime in immense quantities (fungi act like animals in excreting it), and winds diffuse it widely. These two forces are so adequate to the task of disposing of the gas that it is believed that combustion and respiration together are not sufficient to increase the average above .3 per thousand (or three parts in 10,000, which is the amount allowed for good average air), provided its natural diffusion by winds is not interfered with.

As a matter of fact, investigations of air in the rural and town districts show comparatively small variations in carbonic acid present; for instance:

Scotland, rural and hilly district, - - -	.0336 per cent.
Glasgow, open parts, - - - -	.041 "
London, open parts, - - - - - -	.030 "
Average of the whole city (Nov.) - -	.043 "

The increased percentage found in cities, doubtless comes from the confinement of air in narrow streets, back alleys, etc. This fact should suggest to us the

importance of planning wide, straight streets, and of introducing parks and open spaces into our towns and cities, where the winds can have free access. The air of parks is very nearly equal in purity to that of the country, as the above statistics indicate.

Carbonic acid is considered an index of the pollution of the atmosphere, not because it is necessarily harmful in itself in moderate quantities, and when in an otherwise pure atmosphere, but because any marked increase over the normal amount in the atmosphere is almost always associated with the increase of certain other impurities of great importance. Persons have endured an atmosphere highly charged with pure carbonic acid, as in manufactories for soda-water where the gas has accidentally escaped in large quantities, without any uncomfortable effect; and Pettenkofer has passed some hours in an atmosphere containing 1 per cent. of carbonic acid without any discomfort. Another experimenter felt no difficulty in breathing in a cellar containing fermenting wine with a proportion of 4 per cent. carbonic acid. In spite of these and similar experiences, however, it is found that in an inhabited room an increase of carbonic acid of six to seven parts per 10,000 over and above its normal proportions is attended with headache, dizziness and malaise, and that with a protracted stay in such atmospheres, as in school-rooms, asylums, etc., symptoms of anæmia and predisposition to lung difficulties are exhibited. Observations show that carbonic acid in

proportions of 15 per 1,000 produces headache, 25 per 1,000 extinguishes light, 50 per 1,000 produces insensibility. In all these atmospheres, however, it should be noted that the source of this increased percentage of carbonic acid is the respiration of human beings, and that the absence of oxygen and the increase of heat, humidity, organic matter, acids of perspiration, etc., are simultaneous with that of carbonic acid, and are to be credited with their due share of the ill effects experienced.

The *Organic Matter of the Atmosphere*. In addition to the variable amount of organic matter which is due to dead or living organisms present in the dust of the air, there is a certain exceedingly small amount given off in the breath of human beings, which gives the characteristic foul odor to overcrowded rooms. This is believed to be molecular in its nature, is quite improbably poisonous, and is not easily diffusable. It is easily absorbed by woolen and other heavy fabrics, feathers, etc.

The amount of this organic matter (aside from micro-organisms and other dust of the atmosphere) is certainly very small, and it is difficult to estimate and examine. Scrapings from the furniture of unclean and ill-ventilated apartments, where the characteristic "close" odor of foul air is apparent, show that this is of a nitrogenous nature. It yields ammonia, darkens sulphuric acid, decolorizes nitric acid, and renders pure water offensive. Whatever definite compound, if any,

this may be proved to be, it is certain that an *odor* is perceptible in all overcrowded, illy-ventilated rooms, and that this increases and remains permanent where these conditions are constant, as in the dwellings of the uncleanly poor; and that where fewer persons, better ventilation and greater cleanliness exist this foul odor is lacking. It is certain, moreover, that persons exposed to such atmospheres generally exhibit a low state of health not directly traceable to any infection from specific bacteria, and a generally lessened resistance to disease.

Further investigation as to the cause of this odorous element is desirable, inasmuch as we know that neither carbonic acid nor micro-organisms are specifically malodorous. In the meantime, however, the fact that such odors may exist under conditions of badly-ventilated and imperfectly-cleaned apartments emphasizes the need for non-absorbent, washable materials in living rooms, as well as smooth surfaces which can be easily cleaned. Adequate provision for ventilation will be discussed hereafter.

IMPURITIES OF THE ATMOSPHERE.

I. *Gaseous.* The normal purity of the atmosphere is liable to constant vitiation from various sources, among which are the respiration and transpiration of human beings, the trades and industries of man, and the decomposition of organic matter on the earth, as well as other sources to be mentioned.

Air is changed by Respiration, briefly, by losing 4 per cent. of oxygen and by gaining 4 per cent. of carbonic acid, while the nitrogen remains unchanged. Watery vapor is also thrown off from the skin and the lungs in amounts that vary with the temperature and the hygrometric condition of the atmosphere. It has been estimated at from 10 to 22.5 oz. in the twenty-four hours, and requires about 210 cubic feet of air per hour to sustain it in a state of vapor. The organic matter of the air has already been spoken of; it becomes perceptible to the sense of smell when the carbonic acid in an inhabited room amounts to .7 per 1,000 cubic feet of air. A certain amount of ammonia is also added to the air by respiration and transpiration. Persons exposed for a short time to air vitiated by the respiration of human beings become drowsy, have headache, and sometimes nausea. With a longer exposure, languor, anæmia and a predisposition to respiratory diseases occurs.

Instances are numerous showing the ill effects of breathing air contaminated with respiratory products. The story of the Black Hole at Calcutta is classic. Here 146 prisoners were confined in a space of twenty feet square for ten hours, at the end of which time only 23 were alive, and in them a fatal fever supervened. In the case of the steamer Londonderry (1846), 200 passengers were confined in the hold; each had but four cubic feet of air space; 72 had already died when the hatches were opened, and others soon followed.

The experience of surgeons in our Civil War proved that the rudest shelter is preferable to overcrowded barracks, and that surgical cases made more rapid recovery when practically living out-of-doors than when in any hospital accommodations. In the Afghan War pneumonia was very prevalent and fatal in the overcrowded barracks, while there was not a single case among those dwelling in tents. The distributing of the other men in tents had the effect of at once stopping the disease.

Impurities from Trades, Industries, etc. Various gases may enter the atmosphere from industrial activities. Manufactories, chemical and otherwise, copper works, cement and brick fields, combustion in general (the burning of coal and wood for heating and lighting, and the manufacture of gas) are some of the sources of such gases.

Among the more common of the products from the manufactories referred to are compounds of carbon, as carbonic acid gas, carbonous oxide; compounds of sulphur, as sulphurous and sulphuric acids, also sulphuretted hydrogen from bleaching establishments; compounds of hydrochloric acid from alkali works, hydrogen sulphide from the manufacture of matches. These are deleterious to health. Illuminating gas, which is the more or less purified product of coal distillation, is a mixture of hydro-carbons, carbonous oxide, sulphuretted hydrogen, nitrogen, sulphurous acid and ethylene, etc., etc. In its manufacture these

gases are set free. Coal used for heating purposes produces carbonic acid, carbonous oxide and various sulphur compounds. Wood produces fewer sulphur compounds. The carbonaceous and tarry products diffuse less readily than the others, remaining more or less suspended in the lower air, where in excess they may excite asthma, bronchitis, etc. The noxious qualities of a London fog are largely due to the sulphur contained in the coal used in domestic fireplaces (Sykes). It should be noted that while the substances produced by the combustion of coal for heating pass for the most part through chimneys into the outer air, the products of illuminating gas pass into and may remain in the dwelling-rooms, unless an outlet is provided for them.

The effect of breathing air vitiated by the products of illuminating gas is seen in shops where gas is the only means of lighting. Bronchial affections are very common, and workers in such shops generally appear more or less anæmic.

Undoubtedly, the actual privation of sunlight to which they are subjected partly explains the anæmic appearance of such persons; but that this is not the only reason the following instance demonstrates: In the savings bank department in Queen Victoria Street, London, where twelve hundred persons are employed, the introduction of the electric light in place of gas has so reduced the absences from illness that the extra labor gained has paid for the plant.

Decomposing organic matter, both vegetable and animal, gives rise to various evil-smelling gases.

Badly ventilated privies, sewers, foul streams, decomposing carcases and all putrefying organic matter originate these in greater or less abundance. Sulphuretted hydrogen, which is a frequent product of the decomposition of animal and vegetable matter, may come from this source. This gas is said by Letherby to be destructive of human life if maintained in the proportion of one per cent.

The Air of Marshes contains an excess of carbonic acid, watery vapor and sulphurous acid; free hydrogen, ammonia and other gases have been detected; but the ill effects of such air are believed to be due more to organic elements present giving rise to malarial fevers than to its gaseous constituents. The air of graveyards would seem to be prejudicial to health, yet those in the neighborhood of well-regulated cemeteries do not appear to suffer from their location, nor do grave-diggers apparently suffer in health from their calling.

Owing to the beneficent processes of nature, which include the absorption of carbonic acid by the vegetable world, the diffusion of gases and the purifying effects of winds and storms, these impurities seldom accumulate in large quantities in the atmosphere. When individuals are exposed to them, however, in undiluted amounts, certain symptoms may result varying with the sensitiveness of the subject as well as his habituation

to the poison. A foul odor is sickening to most individuals, and long exposure to such an atmosphere will in most cases produce nausea, vertigo, headache, as well as more serious symptoms. Children and, in general, house-dwellers are particularly susceptible to the influence of sewer air, and instances of diarrhœa and predisposition to sore throats frequently occur after such exposures. The opening of vaults and of foul cesspools has been followed by insensibility, and even long illness. On the other hand, workmen who are constantly employed in ordinary sewers apparently become accustomed to the air, and, according to statistics, appear to suffer more from rheumatism and diseases associated with dampness than from those attributed to sewer gas.

Foul air, as pointed out by Flügge, is commonly, however, a means of *intoxication*, not of infection. The system may be overcome by its effects, as shown by the symptoms of oppressive breathing, restlessness, noise in the ears, confusion in the head, etc.—followed, when fatal, by spasms, asphyxiation, etc.—but these are not the symptoms of *infection*. Infection can only result from impure air, when such air contains, in the shape of dust or otherwise, the living germs of the infectious diseases which the subject breathes in or swallows. Therefore, diphtheria or typhoid fever does not come from sewer air, *i.e.* from *gases*, however bad-smelling, unless germs of the disease have been blown up through the pipes into the dwelling-rooms, and so

become a part of the atmospheric dust. This means of infection comes under the second division of the impurities of the atmosphere, viz., Dust. Intoxication, then, may result from gaseous impurities. To learn how infection may result from impure air we must study "The Solid Impurities of the Atmosphere."

II. *Solid Impurities. The Micro-organisms of the Air.* The dust of the atmosphere represents its solid impurities; and although on mountain-tops or in mid-ocean the air is practically free from dust, this element becomes in all civilized regions an impurity of great hygienic significance. Dust may be of animal, vegetable or mineral origin, but commonly includes all three in a minutely pulverized state, blown from far or near. The débris of dead and living organisms, fragments of steel, iron, sand, the pollen of plants, bits of cotton, linen, feathers, pulverized excreta from the streets, and on the sea-coast salt from the ocean, are all represented in more or less abundance in dust. The air of Berlin is said to contain organisms derived from the African desert, while the sails of ships 600 to 800 miles from Africa are red with its sand.

This material would be of small importance in the quantities usually found in clean towns or in dwelling-houses were it not for the micro-organisms which are carried with it, adhering to the rough surfaces of these loose particles, or even floating freely with them. It is the presence of micro-organisms in dust, therefore, particularly the bacteria, that gives it its hygienic sig-

nificance, inasmuch as among these may be many which are of a pathogenic nature.

The number of these micro-organisms varies with the time of year, the location, the condition of the weather (winds, rain, etc.), as well as with the hour of day. They are more numerous in high temperatures, in busy thoroughfares, and in dry weather. Winds carry them away, and rains wash them out of the atmosphere down to the earth.

They belong to the orders of moulds, yeasts and bacteria, the latter being the more numerous. Miquel found in ten litres of air six bacteria on the Atlantic Ocean, one on high mountains:

Summit of the Pantheon (Paris),	200
In new houses,	4,500
In sewers,	6,000
Old Paris houses,	36,000
Hôpital de la Pitié,	79,000

Carnelly found in houses called clean 180 bacteria in 10 litres of air, while in very dirty houses there were over 900. In dirty school-rooms with the so-called natural ventilation, he found nearly 2,000 living bacteria in the same volume of air, while in mechanically ventilated schools there were from 30 to 300.

In quiet air they fall to the ground, or to the floor if in dwelling-houses. *They do not voluntarily rise from damp surfaces.* They attach themselves most readily to rough surfaces, as draperies, upholstery, carpets, etc., from which they are not removed by ordinary currents of air—from which it is evident that

other means than ordinary ventilation are necessary to preserve the air of dwelling-houses pure, viz., proper dusting and cleaning.

Pathogenic bacteria are seldom found in ordinary atmospheric air, as winds and constant atmospheric movements dilute or carry them away—even a few metres distance from a small-pox hospital being probably sufficient to insure safety. They are most numerous in crowded and narrow rooms, depending on cleanliness and atmospheric quiet.

The bacillus tuberculosis has been found on the walls of hospitals, as has that of typhoid fever, also pyogenic bacteria, the bacteria of erysipelas, and others. In such places careless dusting and sweeping of the rooms only tend to dislodge the germs and throw them back into the air of the rooms, where they may be breathed in by the inhabitant. This, then (the air of dwelling-rooms), is the great field of danger. "Dusty air in a close room is a much fairer indication of danger than evil-smelling air."

Bacteria are not derived from the person himself, *e. g.*, from the lungs, skin or breath, but are brought in as dust and dirt on clothing, shoes, etc. In very dirty rooms or during infectious diseases in houses they may indirectly become a source of danger by dropping into food or milk.

The practical result of our knowledge regarding the presence and habits of bacteria in the air, should be:

(1). To induce greater care in the cleaning of city

streets. Streets should be smoothly paved to prevent the retention of dirt in corners and rough surfaces; they should invariably be sprinkled before they are swept. All dust and dirt and garbage should be collected in closed carts, by which the wide distribution of the street collections by winds will be prevented.

(2). Proper cleansing of public buildings, theatres, schools, boats and railroad cars should be insisted upon by law.

Through these buildings, seldom properly ventilated, large bodies of people pass every day. These persons bring in dirt on their shoes and clothing which is naturally rubbed off on carpets and furniture. In most such buildings and conveyances feather dusters are the only means used for cleaning, and dry sweeping is practised. The duster only dissipates the dust from smooth surfaces where it declares its presence, to carpets or walls or upholstery where it is not observed; but the dust is not removed from the building by such proceedings. The floors of such buildings should be sprinkled with wet sawdust, wet bits of newspapers or similar materials to prevent the dust from rising, and all dusting should be done with damp cloths. Expectorating on the floor of any building or conveyance should be forbidden by law, as it is by decency. Unquestionably a vast amount of tuberculosis is induced by this filthy American habit. The sputa of a tuberculous patient may contain millions of the germs of this disease. Being deposited upon the floor the sputum

dries, and is soon ground up and dispersed in the dust of the place. This germ is not destroyed by drying, and is then in a favorable condition to be widely carried by winds into the air, or to adhere to shoes or to women's long skirts, and to be thence conveyed into houses where it may enter the lungs of individuals.

Cultivations of bacteria have been made from the hems of long dress skirts that have swept the streets or other places, and the bacillus of tuberculosis, as well as other bacteria, have been found. That refined women who court dainty attire and extreme nicety in matters of the toilet should permit themselves to sweep the streets, theatres or other places with their long dresses, gathering up filthiness unimaginable, is an astonishing spectacle; no intelligent or conscientious woman should permit herself to spread disease in this manner, as unquestionably it is spread through such means.

(3). The careful cleaning of private houses according to these principles, and their furnishing in accordance with styles compatible with thorough cleanliness, should be practised. Details will be further considered under the head of The Dwelling.

Unhealthy Occupations as related to dust. The majority of the industrial occupations of mankind may be said to be injurious or otherwise, according to the purity of the air present; and the condition of the air which is in general most influential is that of the presence or absence of dust.

The general condition of the atmosphere in workrooms of all kinds is extremely bad. The ventilation of such rooms is generally very deficient, and the gathering together of large numbers of persons, as in the factories and large workrooms, increases the gaseous impurities of the air and its watery vapor, as well as heat. These conditions, with the confinement and long hours of work, are in themselves sufficient to induce ill-health.

Special occupations, however, produce dust and gases of various kinds which aside from other conditions seriously affect the health of the workers. Much of this dust is of mineral origin, as in the pottery trades, mines, steel-grinding, cotton-weaving, etc. Miners inhale not only the products of air vitiated by respiration, but also the fine and sharp dust-particles which arise from their work, and these become impacted in the lungs and give rise to chronic inflammation in the tissues.

Steel-grinding as formerly conducted by the dry method had a marked effect upon the mortality of the workers, who almost invariably died from phthisis or other disease of the respiratory organs. The introduction of better ventilation and the process of wet grinding by which the dust is moistened and kept from flying in the air has increased the longevity of such workmen, although respiratory diseases are still very common among them.

Cotton-weavers suffer from the fine dust given off

by "sizing," and affections of the lung, as also persistent epistaxis, are very prevalent amongst this class.

Workers in lead, as plumbers, painters and glaziers, may suffer from lead-poisoning from the absorption of volatilized lead; they may also take it in from eating with unwashed hands.

In general the dust-making occupations have been proved to have an immense influence upon mortality. Taking statistics from England from Ogles' report on mortality of occupation in males in England and Wales, in ages from 25 to 65 the mortality among workers in dust-making trades from phthisis and respiratory diseases is more than double that of fishermen who live a life in the open air. These occupations include miners, carpenters, joiners, quarrymen, earthenware manufacturers, etc. The total number of deaths from these diseases among these men for ten years is compared with 1,000 as a standard for all deaths. Compared with this the mortality of the workers in dust-inhaling occupations is 402 against only 198 among fishermen.

Statistics from the Massachusetts Board of Health report (33d Report) also clearly show the relation of occupation to longevity. According to these, agriculturists have the greatest expectation of life, and next to these come mechanics who are engaged out-of-doors.

Some of the irritating *gases* which occur in various industries have already been referred to.

The means for the prevention of such diseases as

arise from dust, or irritating gases, include: First, preventing these irritating substances from entering the room. This can be effected largely in certain trades by the introduction of substances which will absorb the gases as they are given off (chemical means); and second, by diluting them largely by adequate ventilation. This should be enforced by law.

Moistening of dust, as referred to in grinder's trade, is applicable to other dust-making occupations, and has been proved a very effectual agent in reducing disease in these operatives.

The wearing of respirators which cover the mouth, nose, or both, is also a great protection, although not a popular one with the workmen.

Cleanliness of the rooms should be enforced in addition to ventilation, and operatives should be informed of the dangers they incur, and instructed that personal cleanliness, as of the hands particularly and clothing, is an aid to the prevention of certain affections (particularly lead-poisoning).

EXAMINATION OF AIR.

This may include, in addition to the test by the sense of smell already referred to, by which the presence of organic matter of animal origin is detected: (1). Chemical examination of constituents. (2). Microscopical examination of suspended matter. (3). Study of the micro-organisms, obtained by cultivation, from the air.

(1). The examination of air has formerly been almost exclusively confined to its chemical constituents, including not only carbonic acid but also ammonia, nitric and nitrous acids, the amount of oxidizable substances, etc., as well as the estimation of the watery vapor present.

For the most part these analyses can only be accurately conducted by an expert chemist in a suitably appointed laboratory, with elaborate and expensive apparatus. The detailed consideration of these analyses may be found in any standard chemistry, and will not be here given.

Carbonic Acid is the element in the atmosphere for which tests are most commonly made, for the reason already given, viz.: that this gas is accepted as an index of the pollution of the atmosphere, because, as a rule, other impurities increase with it. The process for the examination of carbonic acid depends upon the fact that this gas is easily absorbed by the hydroxide of an alkaline earth, such as lime-water or baryta-water, and that when it is so absorbed a precipitate results, and the causticity of the alkali is by so much lessened. What is known as Pettenkofer's absolute method of analysis is performed on this principle, but requires much practice and nicety. An approximate method is based on the same principle of the precipitation of lime-water or baryta by carbonic acid, the precipitate being made evident by the turbidity of a solution previously clear. The richer the air is in car-

bonic acid, the less air will be required to impart turbidity to a given quantity of lime or baryta-water.

In making the test, use six bottles, containing respectively 450, 350, 300, 250, 200, 150 cubic centimetres. The bottles are made clean and dry. Fifteen cubic centimetres (3¾ drachms) of clear, fresh lime-water are put into the smallest. The cork is replaced and the bottle well shaken. If the smallest, which contains only a trifle of air, shows turbidity, it is known that the air is heavily charged with carbonic acid. Beginning with the largest, the bottle containing 450, for instance, may not show any turbidity, but if that with 350 shows turbidity it indicates 7 parts of carbonic acid to 10,000. If the fourth smaller bottle is turbid, it shows 10 in 10,000, the fifth (200 cubic centimetres) shows 12, and if the sixth and smallest should be made turbid, it would indicate 16 volumes of carbonic acid in 10,000 of air, or about five times the atmospheric amount. A small piece of paper may be gummed to the side of the bottle of lime-water, marked with a cross in lead-pencil. When the water becomes turbid the cross will be invisible. Any turbidity except in the largest, shows that the amount of carbonic acid exceeds the allowance.

The "air-tester" is an easily-managed instrument for the same purpose, devised by Prof. Wolpert, a German meteorologist, and depends upon the same principles.

Ozone. The tests are all more or less unsatisfactory. One of the ready tests proposed is to expose strips of iodized litmus paper to the air, when the greater or less conversion of red litmus paper into blue, shows a greater or less quantity of ozone present.

(2). *Microscopical Examination.* This may be made to ascertain the varieties of coarser dust-particles in the atmosphere. Direct examination of dust deposited on a given surface may be made under the microscope, or the air may be aspirated through a bottle or tubes filled with distilled water, and the water then examined for solid impurities.

(3). *Bacteriological Examination.* The knowledge that certain infectious diseases may be communicated by bacteria which float in the dust of the atmosphere has, of late, given significance to the bacteriological study of the dust of the air.

In such analyses we wish to discover both the kind of germs present and also the probable number in a specimen of air. For a *qualitative* analysis of the micro-organisms of the air, a simple procedure is followed.

Small glass dishes, known as Petri's plates, previously sterilized, are partly filled with sterile liquid gelatine, and are then exposed to the air in question for a known time, five or ten minutes. At the end of this time they are covered and set aside, and at the end of two or three days, the organisms which have dropped into the plates will have developed, and may

be seen in the form of little dots on the surface, or as moulds, etc. These may then be cultivated and studied in the laboratory to discover their species.

In order to make a *quantitative* analysis, we may follow Petri's method, by which a known quantity of the air to be examined is passed through a small filter of previously-heated (sterilized) sand. He then trans-

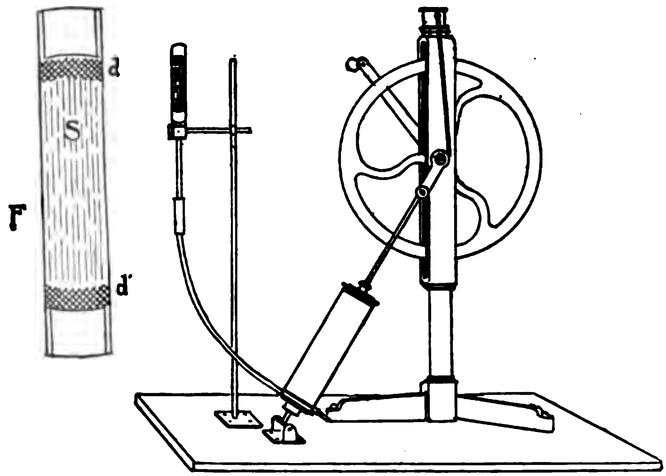


FIG. 2.—PETRI'S APPARATUS FOR AIR ANALYSIS.

fers the sand into test tubes of liquid nutrient gelatine, pours the latter into glass dishes as above, and observes the colonies as they develop. The filter referred to is a small glass tube 1.5 centimetre wide into which sand is put in a small plug, about 3 centimetres long, supported on both sides by a fine wire screen. This is connected with an air-pump whose

rotations are counted, and which indicates the quantity of air sucked in through the sand by a registering dial (generally ten litres in one or two minutes in Petri's experiments). Modifications of this method are now used, both as regards the style of pump and the arrangement of the filter, but the principle is the same. Fig. 2, from Gärtner, illustrates Petri's apparatus after the filter is in place. *F* shows the filter in near view, *S* being the sterilized sand, *d* and *d'* the copper wire supports introduced.

In ordinary air the number of germs is not large, but this varies with location, quiet and cleanliness, as already shown.

CHAPTER IV.

CLIMATE.

The study of climate is perhaps more directly related to therapeutic than to hygienic measures, as change of climate is generally ordered for the relief of existing disease.

It may be prescribed as a preventive measure in certain cases, but practically man is mostly concerned in learning how to adapt himself to the various climatic conditions in which he finds himself placed, and this is done to a large extent by variations in clothing and food.

"Climate may be described as the condition of a country relative to all those atmospheric phenomena which influence organized beings."

These include its temperature and moisture, the density of the atmosphere, the amount of sun and cloudiness, of snow, hail and rain, the frequency and force of the winds, fog, etc.

These phenomena are largely influenced by the conformation of the earth's surface; as, for instance, altitude influences the density of the atmosphere, large bodies of water influence its moisture, etc.

The influence of these various meteorological

factors which make up the climate of a country have been more or less studied, but more extensive observations are required in order to give greater precision to our present knowledge.

The Effect of Temperature. In general, in hot climates the respirations are lessened; less carbonic acid and presumably less water are eliminated by the lungs. If 10 oz. of carbon are expired in the temperate zone, only 8.15 oz. would be expired in the tropics (Parkes).

The average pulse-rate is slower by 2 to 3 beats.

The digestive powers are somewhat lessened; there is generally less desire for animal food; more for fruit.

The skin acts much more than usual (an increase of 24 per cent.). The urine is lessened in quantity. The effect on the nervous system is generally considered depressing. It should be noted that many of these observations have been taken from Europeans in India, or other hot climates, where many extremely evil conditions of life exist, from a sanitary standpoint, which doubtless have a coincident influence upon the functions of the body.

Rapid changes of temperature are certainly trying to the body, and are only to be safely met by suitable variations in clothing.

Climates with extremely high and very low temperatures have certain diseases which are peculiar to them. In tropical climates some of these are liver diseases, chronic and acute intestinal catarrhs, cholera, anæmia.

Bronchitis is not infrequent, and phthisis and pneumonia are fairly common, except in certain parts of Egypt, India and Tunis.

Extremely low temperatures, as in arctic regions with long nights, induce a great depression of the nervous system, dyspepsia and irritability. Diseases of the respiratory organs may exist, but not phthisis. Malaria, cholera infantum and intestinal diseases are not found.

Temperate climates show a wide range in the thermometer, and diseases likewise range almost over the entire scale of disease.

Pressure or *Density* of the atmosphere varies with the altitude of a locality. In ascending mountains there is rarefaction (lessened pressure) of air. The physiological effects of this begin to be perceptible at 2,800 to 3,000 feet above the sea; they are quickened pulse (fifteen to twenty beats per minute); quickened respiration (ten to fifteen respirations per minute), with lessened spirometric capacity, increased evaporation from skin and lungs, and lessened urinary water. At great heights there may be swelling of superficial vessels and hemorrhages from nose or lungs.

Some of the effects of altitudes are doubtless due to the other conditions associated with elevations, viz.: increased light, greater sun radiation in absence of clouds, lowered temperature and greater movements of the air. There are fewer micro-organisms present in the air of elevated regions. Generally, digestion and

sanguification are improved, and it is believed that tissue change is accelerated by a rarefied atmosphere,

The effects of increased pressure have been noted in divers. The pulse is slower, respirations slightly lessened, the blood is driven from the skin to internal organs; there is said to be increased appetite and vigor. On leaving places filled with compressed air workmen may suffer from hemorrhages and nervous affections.

Humidity. The capacity of the atmosphere for moisture varies with the temperature. An atmosphere loaded with moisture depresses the action of the skin, diminishes the radiation of heat, and therefore produces extreme discomfort in hot climates, but less in cold.

More carbonic acid is said to be exhaled in a moist atmosphere than in a dry one.

The most agreeable amount of humidity is commonly felt to be that when the relative humidity is between 70 and 80 per cent.

The spread of certain diseases, notably malaria, is supposed to be intimately related to the humidity of the air.

On the contrary, small-pox is checked by a very dry atmosphere.

Winds, or movements of air. Winds if cold abstract heat from the body in proportion to their velocity; if hot and dry, they may increase evaporation. Extreme cold may be borne in a very quiet

atmosphere without discomfort, while any movement of such cold air induces great chill.

The *Cloudiness* or absence of clouds—(light and sunlight)—is certainly an important consideration in climate, judged from what we know of the effects of light on growth. The darkness of the arctic climate is known to be extremely depressing to the nervous system of travelers. On the contrary, there is a general feeling of buoyancy on a bright day that probably has its physiological basis. The light at the sea-shore has been calculated by certain experiments in timing photographic plates, to be 18,000 times stronger than that of shaded rooms.

A photographic plate exposed on the sea-shore required only one-tenth of a second to "fix" it. On an open landscape it required one-third of a second; in a fairly lighted interior, two and one-half seconds; and in a badly lighted interior, one-half hour.

It is probable that this element in climate is of great importance in stimulating tissue-change, and promoting growth.

The vast territory of the United States affords an opportunity for more extended. observations upon climatology and meteorology than any other country, since its range of temperature and other atmospheric conditions is extremely wide.

Many valuable contributions to this study have already been made by the United States Signal Bureau, which bid fair to be of great service to hygiene.

The following statistics relating to climate in the United States are from Parkes' American appendix:

The hottest portion of the United States is in the southern end of Florida; and next to this, southern Texas and southwestern Arizona. The mean annual temperature of the whole country is not far from 53° F.

The coldest regions are found in the northern part of New England, northern Michigan, Wisconsin and Minnesota, and the high mountain region of the Cordilleras.

The highest maximum temperature is reported from southwestern Arizona and southwestern California—being given as 135° in the shade. The average maximum on the Pacific coast is lower than on the Atlantic.

According to Government statistics, 98 per cent. of the population of the United States live in regions with mean annual temperatures ranging between 40° and 70° F., and 97 per cent. are exposed to summer heats, which have a range of 20° only—the mean July temperatures being between 65° and 85° F. This leaves only 3 per cent. who suffer a more intense average of heat and cold.

As regards rainfall nine-tenths of our people are settled where the average annual rainfall is from 30 to 60 inches, and 95 per cent. where the rainfall in spring and summer months ranges between 15 and 30 inches. The average annual rainfall, exclusive of Alaska, is about 29 inches.

Dennison's climatic charts illustrating the percentage of annual cloudiness and of atmospheric humidities for winter, the result of ten years' observations in the United States, are an excellent object lesson in these subjects and well repay study.

The various conditions of climate are, as far as

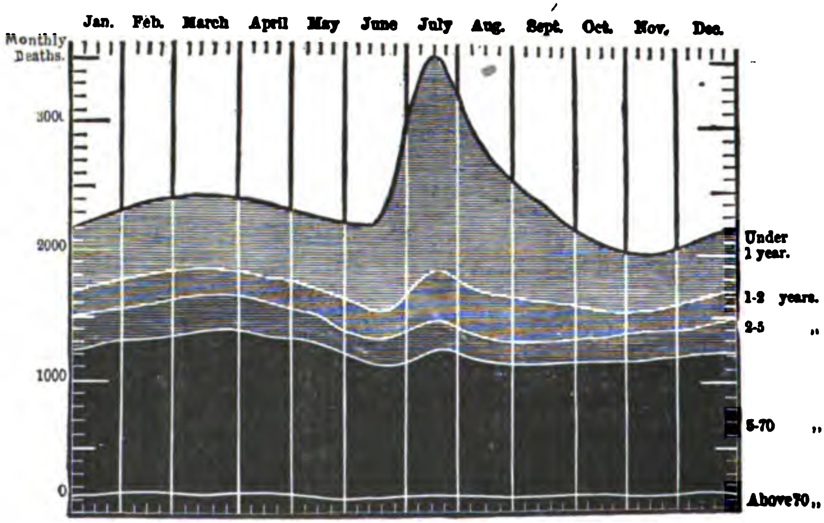


FIG. 3.—SEASONAL CHART, SHOWING MORTALITY AT DIFFERENT AGES FOR BOTH SEXES AND ALL CAUSES IN THE CITY OF NEW YORK.

possible, accurately recorded by numerous observers at different Signal Service Stations all over the United States, and bulletins of these observations are transmitted to the central office, whence they are sent as a daily weather map, as far as possible, over the country, and certainly afford a basis for prevention of such

diseases as are due to unexpected changes of the weather.

Combined with local observations still greater progress toward precision in forecasting weather may be made, which should eventually prove extremely useful to physicians and sanitarians. The instruments made use of are barometers, thermometers, hygrometers, anemometers, rain gauges, etc., to estimate respectively density, temperature, humidity, the force of winds and amount of rainfall; and minute directions as to the use of these are given in the "Signal Service Instructions."

Fig. 3, which gives the mortality curve at different ages for all causes in different seasons of the year in New York, indicates the influence of changes in climate due to season and variable weather upon life and health. (From Fox, "Sanitary Examinations of Air, Water and Food.")

CHAPTER V.

THE SOIL AS RELATED TO HEALTH.

The soil, in the sense of the crust of the earth, is of interest to the hygienist because of its relation to climate, to water which passes through it, and to dwellings for which it is the foundation.

Climate is particularly influenced by the dryness or the dampness of the soil. This, in turn, is affected largely by certain physical conditions, such as the constitution of soil-particles, according to which they retain or throw off water, the air spaces between these, the conformation of the land in question (whether hills or plains), which affects natural drainage, and other similar considerations, some of which properly come under the head of Climatology.

The crust or soil of the earth provides a bed for all surface waters, as lakes and rivers, and serves as a filter for all sub-surface waters—springs, wells, etc. It is this important office of a filter for our water supplies that gives it special hygienic significance, and this function is made possible by the activity of the micro-organisms of the soil already referred to. The influence of soil upon water is therefore always beneficial so far as purifying it from organic contamina-

tion is concerned, provided man does not interfere with its natural functions by overtaxing its purifying powers, in ways to be referred to later.

As a foundation for habitations soil is desirable or otherwise, principally from the aspect of dryness or dampness, it being understood that we speak of it in its natural condition, not after it has been made filthy by artificial means. Observations of sanitarians all agree in considering a damp soil as a great predisposing influence to disease. This relation is particularly marked in rheumatism, malaria, and also in phthisis. Before the bacterial origin of phthisis had been proved by Koch, Bowditch in America, and Buchanan in England, had each pointed out the coincidence of consumption in both countries with dampness of soil.

Statistics from English towns giving the mortality rates before and after sanitary improvements in drainage of the soil and sewerage, showed a saving of life in the towns of

Banbury,	in	typhoid fever,	of 48	per cent.	phthisis,	41	per cent.
Croyden,	"	"	63	"	"	17	"
Dover,	"	"	36	"	"	20	"
Rugby,	"	"	10	"	"	43	"

with similar notable results in other localities. While we must attribute the improved rate in typhoid fever mortality in these towns to the purification of drinking water incident to the removal of sewage contamination, that of phthisis can have no such relation.

Dampness of soil means dampness of house, cellars, walls, etc., and it is unquestioned that these conditions have a marked influence upon the general health of the inhabitants.

The exact chemical conditions of soil which favor the production of malaria are unknown, and the mineral constituents appear to be of little consequence, as the disease may appear on chalk, limestone, or even granite. It is almost invariably associated with dampness, however, although exceptions to this rule have occurred, and the effect of draining malarial regions, as shown by the reduction in malarial diseases, is one of the best authenticated triumphs of sanitary engineering both in England and in America. Dwellers upon damp soils appear to be especially predisposed to catarrhal difficulties of the throat and bronchi, and to a general lowered state of health, anæmia, etc.

The constitution of the soil influences its porosity and permeability to water, while its temperature is also largely influenced by such conditions as color, amount of vegetation, etc., both of which affect the absorption and radiation of heat.

ORIGIN AND CONSTITUTION OF SOILS.

All soils have been derived frem previously existing rocks, by the disintegrating action of water, frost, ice, vegetation and time's decay. A large portion of the soils of North America is due to the geological period known as the glacial epoch. "During this

period a great ice-sheet many hundreds of feet in thickness advanced over North America from arctic and sub-arctic regions, extending southwardly to the coast of New England and Long Island, the Narrows of New York harbor, and thence across the continent, its southern margin following approximately the 40th parallel of north latitude to the Missouri river; thence bending northward it joined with another sea of ice which descended from the Rocky Mountains, as far south as the 30th parallel."—(Parkes). The immense amount of débris collected by this ice included all varieties of soil as may be imagined from its origin, differing radically from one another in areas of a few feet.

Soils of Glacial Drift. In general these deposits are clay, sand, gravel, and boulders with little or no stratification. They are generally permeable soils, and therefore afford good sites for habitations; but if they rest upon a stratum of impermeable clay are not good, as drainage for this reason is interfered with.

Soils of Stratified Drift were derived from the currents of water, and the lakes which accompanied the meeting of the glaciers. They are found in well-marked strata of clay, sand and gravel in successive layers. When mostly composed of sand and gravel they constitute the most salubrious soils of America, as they offer excellent drainage, retain heat, and are free from organic matter. The "Yellow Drift" (so called from its predominating color) is the most notable of these soils, found over nearly the whole extent of

Long Island, composing the soils of southern New Jersey, of Delaware and of eastern Virginia. Isolated patches occur in New England, and it is traced even to Florida along the sea-coast. Much of this territory is covered with pine forests, and many of our most celebrated seaside health resorts are situated on these soils, and, doubtless, owe much of their salubrity to their constitution. When these soils, however, have a substratum of clay, they are impermeable to water, and hence, cold and undesirable for building sites.

The Flood-Plains about rivers are generally but slightly elevated above the stream, and are largely composed of clay with fine silt; and although often rich in appearance are generally malarial, as the drainage is bad.

Marsh Soils consist of clay or sand mixed with a large amount of decaying organic matter, and saturated with water. "A marsh is a water-tight basin filled with peat and saturated with water." Such soils are highly malarial. The growth of cities has often impressed them into its service for building sites, but their complete artificial drainage is the only means of rendering them healthy. Marshes abound along the coast of the Atlantic Ocean and the Gulf. The Dismal Swamp in Virginia and the Everglades in Florida are noted examples. In some regions marsh soils are composed of true peat, which is due to the growth and decay of moisture-loving plants; these, as "peat-bogs," are very prevalent in the Old World, but less so in the

United States. Such soils appear not to be malarial, owing doubtless to the antiseptic powers in the acids in the plants, (crenic, etc.).

The alkaline soils of the far West are mostly composed of light loam, with an abundance of chlorides, of soda, potash, magnesia, etc., and as they render the waters intensely saline and purgative, the occupation of these soils for dwelling is improbable. For obvious reasons, the soils described are termed Transported Soils.

Indigenous soils are those derived directly from the disintegration of the rocks *in situ*, and their healthfulness is consequently determined by the character of the rock to which they owe their origin. The principal varieties of these are granite, slate, sandstone, limestone, etc. Any of these soils if they have a good natural slope or if they are permeable to air and water, permitting evaporation of moisture, and ventilation, may be healthy. With the opposite conditions they are undesirable. Such soils are generally divided into three varieties—sandy soils, which contain about 75 per cent. of quartz; clay, which has 75 per cent. of silicate of aluminum; and loam, which is a mixture of the two. They all contain air and water in their interstices in proportion to the size of these.

THE AIR IN SOILS.

All soils contain air in their interstices in greater or less amounts, varying with the size of their particles.

Loose sands may contain from 40 to 50 per cent. of air. The principal noteworthy feature of ground air is the excess of carbon dioxide. The carbon dioxide may vary from 2.4 volumes per 1,000 to 9.74. The presence of carbon dioxide in excess points to great chemical activity in the soil, or it may be due to the fact that the soil is impermeable, and the gas consequently accumulates without sufficient means of escape. Ground air is generally saturated with moisture. It may contain traces of ammonia, also of sulphuretted hydrogen, if sulphates are present in the soil. Oxygen in the ground air varies with the depth of the soil, being deficient at a great depth. Thirteen feet below the surface, air is said to be irrespirable. Movement in the ground air is caused by rain, changes in temperature, changes in the level of the subsoil water, and other causes which may be more local. The air under dwellings is influenced by the heat in cellars, and in winter the difference in temperature between indoor and outdoor air may cause currents of air from most undesirable sources—such as old cesspools, broken-down sewers and other impure sources—to pass into the house. Coal gas from leaky pipes has been found to travel a long distance and to enter dwellings; and an instance is recorded of poisoning by carbonous oxide, owing to air from a disused mine having been aspirated in this way into the basement of a house in its proximity. The subsoil water in its fluctuations may drive the ground air upward; while rain beating on the

surface of the earth would displace the air downward. The action of winds in inducing movements in ground air is also considerable. A wind blowing at the rate of fifteen miles per hour exerts a pressure of 1.10 pounds upon a square foot of surface, and with a velocity of a hundred miles per hour—a hurricane—the pressure rises to 50 pounds to the square foot. The following experiment by Pettenkofer illustrates the motion of the air through the earth (Fig. 4, after Buck). *A*

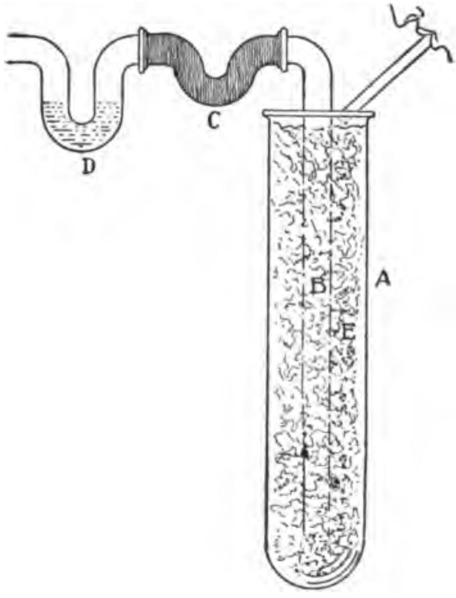


FIG. 4.—PETTENKOFER'S EXPERIMENT SHOWING POROSITY OF THE SOIL.

represents a tall glass tube, filled with gravel, *E*, in the axis of which stands a smaller glass tube, *B*; one open end of it reaching to the bottom. The other open end

of the small tube is attached by means of a piece of india-rubber tubing, *C*, to a U-shaped tube, *D*, containing water. "If a person blow, as represented in the figure, on the surface of the gravel, the liquid in the U-shaped tube will be seen to alter its position; the level of the side next to the person who is blowing becoming lowered, and the other proportionately elevated. The depression of the fluid is caused by the force of the air blown through the gravel, which ascends from the bottom of the gravel through the small tube, passes through the rubber tube, and thus reaches the water." If the water in the tube, *D*, be removed, it will be possible by blowing upon the surface of the gravel to force sufficient air through the opening beyond *D* to blow aside the flame of a candle.

As a protection against ground air contaminated by foul gases and also against dampness, dwelling-houses should have the cellar or basement well cemented, and the walls made damp-proof by means to be described later.

THE GROUND WATER.

Water is present in all soils in two conditions, viz.: As *moisture*, which term is used to refer to the water that is present mixed with air in the interstices of soils; and second, as *ground water*, which refers to the subterranean body of water which is everywhere present at varying distances from the surface. The

surface of this sheet of water is called the water-table.

All soils, even to the hardest rocks, have the capacity of absorbing moisture. It is said that granite and marble will retain as much as a pint of water to every cubic yard; loose sands, two gallons to a cubic foot; and clay, as much as 20 per cent. of its weight. A new, well-made brick will hold as much as a half-pint of water.

The principal sources of ordinary moisture in the soil are rain and the distillation of water from the subterranean ocean. The soil will retain this moisture in proportion to its evaporation, its inclination, which promotes or retards drainage, and also according to the force and frequency of winds in the vicinity. Soil also has the power of attracting vapors of water from the air, which property is of importance in a rainless region. As the subterranean water-bed rests upon underlying impermeable strata, their arrangement and dip influence its depth. It may rise anywhere from 2 to 100 feet from the surface. It is constantly changing its level, and this change is due partly to rainfall, partly to pressure from the sea, to obstructed outflow, etc. The pressure in the river Rhine is said to have affected a well 1,670 feet distant, and that in the Danube one 2,700 feet away. These changes in the water level are believed by certain eminent observers to have a marked influence upon the health of the community in which they

occur. Pettenkofer's investigations in and about Munich have convinced him that lowering of the ground water is coincident with and a great factor in originating the epidemics of typhoid fever which have many times visited that city. The majority of observers do not accept this theory, as the direct relation of typhoid fever to contaminated drinking water is established independent of fluctuations in the level of the ground water.

The ground water is constantly moving, sometimes at the rate of fifteen feet daily toward the nearest rivers or ocean which form its outlet. This onward movement is greatly influenced by the inclination of the soil, as well as by the presence or absence of trees, roots, etc., which obstruct its course. An obstructed outflow which raises the level of the ground water has been the cause of paroxysmal fevers in malarial countries, as shown by Parkes in the local history of India. In soils suitable for building-sites the level of the ground water should be at least five feet from the surface, and a greater distance is desirable.

TEMPERATURE OF THE SOIL.

This is an important factor in climate and also bears upon the life of micro-organisms. The changes in temperature of the soil are mostly confined to its superficial layers. Below a depth of twelve feet the temperature is fairly constant. The color and also the density of the soil influence its temperature, as does

also the amount of vegetation, herbage, etc., covering it. The power of soils to absorb and conduct heat is not necessarily equal to their radiating quality, the influence of color and vegetation being greatest for radiating, density being most important for absorbing heat.

If 100 is taken as a standard for retention of heat, the following table from Flügge gives the comparative retentive power of soils:

Sand with lime,	100
Pure sand,	95
Light clay,	76.9
Heavy clay,	71
Pure clay,	68.4
Fine chalk,	61.8

It will be seen from this that clay is a cold soil and undesirable for a building-site. Vegetation, by the constant evaporation of moisture from its surface, as well as by obstructing the rays of the sun, will reduce the temperature of the soil. Consequently land covered with trees is cooler than naked rock. Herbage also affects both the radiating and the absorbing power of the soil, a difference of 30° F. having been recorded in a tropical country between the temperature of a naked rock and that of one covered with grass. Pettenkofer shows that an oak tree containing 711,592 leaves had from May until October evaporated 25.6 inches of water, or eight and one-third times the rainfall of the region.

MICRO-ORGANISMS IN THE SOIL.

Bacteria are found in the ground in enormous numbers, principally in the superficial layers which afford the necessary conditions for their growth and life. In virgin earth more than 100,000 germs may be present in one cubic centimetre of soil. They are mostly saphrophytes. Spores are very numerous, and are extremely resistant to unfavorable conditions, as of cold, dryness, etc.

The rôle of these organisms in the soil is very important, and has already been referred to. They effect the oxidation of used-up organic substances in the soil, setting free the carbon and nitrogen by their activity, and these with oxygen form carbon dioxide and nitric acid, etc. It has been found that heating the soil to a temperature of 100° C. destroys its power of oxidation, and that chloroform vapor and chlorine gas passed through soil will arrest its oxidating function. Both of these processes kill the germs which live in the soil, and without their assistance these chemical activities cease.

The filtering power of the soil by which the purification of water is effected is due to the agency of these micro-organisms.

These bacteria, which are very numerous in its superficial layers, secrete a certain slimy substance with which they coát the particles of the soil, and when water or other fluids pass slowly over these

particles its organic matter, bacteria, etc., are caught upon this slimy net. Here the micro-organisms of the soil have an opportunity to attack them, tearing apart their elements and appropriating an infinitesimal portion for themselves, and reducing the organic matter from complex and hurtful to simple and harmless elements.

It has been found that even sewage can be purified by passing it through suitable soil, under proper conditions. It has been found, however, that if the fluid to be purified is forced through sand at a rapid rate, the purification does not take place.

When fluids are poured too rapidly upon the soil they wash through the particles without giving these little organisms time to perform their work of slime-making; or if the slime envelope has been formed it is torn by the force of the rapid stream and its function impaired, hence the impurities of too-rapidly filtered water. When the soil is heated as mentioned the bacteria are killed, and therefore no longer perform their beneficent work.

A temperature of about 60° C. and an amount of moisture equal to about four per cent. are said to be the most favorable conditions for the process of nitrification in the soil. Free ventilation is also important. This subject will be referred to later under Purification of Sewage.

The larger proportion of the micro-organisms of the soil are saphrophytes, and are not only harmless but,

as we have seen, most necessary and useful. A few pathogenic organisms have been found to exist in soil, but their power for harm appears to be very slight. They do not find in the soil all the conditions they need for activity, and they are often overcome by the saphrophytic microbes. Even if they do not die they do not rise from the soil while it is damp. They are principally distributed, therefore, by the agency of dust and dirt which may cling to the shoes, or by winds which dissipate them when the soil is dry. They are not easily carried into the ground water under reasonably clean conditions of the soil, as they are filtered out in the upper layers of the soil in the manner described. It is believed that bacteria may be carried up to the surface of soils from its deeper layers by earth worms, which appear to ingest the organisms. The pathogenic organisms which have been found with more or less frequency in the earth, are the bacillus of tetanus, that of anthax, of malignant œdema, and of typhoid fever. Cholera bacilli have not hitherto been found in the soil, but Fraenkel has shown that they can grow and multiply there at various depths. There is reason to suspect that diarrhœa is due to a definite micro-organism which may have its normal home in the soil, but the specific germ has not been isolated.

The lesson we learn in general from study of the physical and other qualities of the soil is that nothing should be allowed to interfere with or overtax its

natural function of respiration. So long as soil is protected from organic pollution, and is drained, if necessary, to keep it dry and to promote its oxygenating function, we have little or nothing to fear from it. Much can be done to reclaim damp and malarial soils, quite prevalent in the United States, by drainage; and although these may not prove good soils for dwellings, they may be made profitable for garden and other purposes, and thereby turned into agencies for good instead of evil.

The Examination of Soil. The *height of the ground water* may be estimated by boring holes into the ground and measuring the height to which the water rises on a rod. The *hygrometric* properties of a soil may be estimated by drying a certain quantity, and then placing it in a bell-jar over water. The excess in weight after several hours' exposure indicates the amount of water absorbed.

The condition of ordinary dampness or otherwise may be practically judged by the character of vegetation present. Swamp grass, for instance, suggests superficial soil-water. Blue grass is oftener found on dry soils.

The *ground air* may be collected in a special apparatus (as Hesse's), and examined in the laboratory in the same manner as atmospheric air.

Biological Examination. A small spoon with sharp edges, which holds about $\frac{1}{50}$ *c. c.*, may be used to obtain some of the soil to be examined, and this placed

in a tube of liquefied gelatin or agar-agar, and thoroughly agitated, so that the bacteria may be evenly dispersed in the media. After these have grown they may be examined under the microscope.

CHAPTER VI.

WATER.

Water is one of the prime necessities of life. In its relation to preventable disease it may be ranked next, if not indeed equal, to air in importance. In its pure state it is composed of two elements, hydrogen and oxygen.

Sources. All supplies of fresh water are ultimately derived from condensation of the aqueous vapor of the atmosphere, in the form of rain or snow. This may percolate through the earth to different depths, where it forms the subterranean ocean already referred to, whence it reappears as springs or wells, or may be collected on the surface and form streams, lakes, ponds and rivers. Some may evaporate where it falls, while some is at once absorbed by the vegetable world. The supply of any region is therefore primarily dependent upon the annual average rainfall. The amount of rainfall in New England amounts to about forty-three inches per annum, that of New York State to about forty-two inches. England receives considerably less than this. It is estimated that on every hundred square feet of ground area occupied by a building

properly roofed in, a little more than sixty gallons of water can be collected for every inch of rainfall.

As immediate sources of water we may classify the water supply of any region into rain-water and water from springs, lakes, ponds and rivers.

Rain-Water. The general impression that rain-water is an ideal source of drinking water, is erroneous. Water is the most universal solvent known, dissolving all the known gases and all solid bodies except the diamond and certain noble metals. Rain-water will vary in purity, therefore, according as it is collected from a pure atmosphere or otherwise. In descending it becomes charged with the atmospheric gases—nitrogen, oxygen and carbon dioxide—as well as such gaseous impurities as may exist in manufacturing communities—coal acids, sulphuric and hydrochloric acid, and nitric acid in minute quantities. It will also be found upon examination to have washed down the solid impurities of the atmosphere, such as dust with all its possible organic impurities, and in the neighborhood of the sea, sodium chloride. Ammonia and nitric acid were found by Bechi, at Vallombrosa in the Appenines, more than three thousand feet above the sea.

The amount of these impurities naturally differs with the locality—the possibility of contamination near towns being vastly greater than in suburban or uninhabited regions. Rain-water, when collected on clean surfaces in country regions, is one of the purest natural supplies, but collected in towns from

the roofs of houses it is too impure for drinking purposes.

The first portion of the water collected on roofs is naturally the most impure, as it washes off the dirt from such surfaces. After they have been cleaned the remainder is comparatively pure. It has therefore been proposed to divert the first portion of rain-water from the cistern or other reservoir, and to carry it down a separate pipe to be dispersed on the ground, and to allow only the second purer portion of the water to pass into the cistern. An apparatus has been invented by Charles Roberts, of England, for automatically getting rid of the first and dirty rain-water falling after drought. It is not in use at present in America.

The cisterns or tanks in which rain-water is stored should preferably be made of slate. The lead of lead-lined tanks is liable to dissolve in the water, while wooden tanks decay and give the water a bad taste. Underground cisterns for the storage of rain-water may be allowed if well built of brick laid in cement, and well covered to prevent surface leakage from surrounding soil. If rain-water is to be used for drinking purposes, it should be filtered through sand and charcoal before being stored in tanks. In Venice, where ordinary wells are impossible, and where the rainfall is abundant, rain-water formerly constituted the drinking water supply. The water was collected from every available source and carried under ground

to tanks filled with sand. The water was thus filtered, and by means of tubes or wells driven into the sand it was pumped to the surface.

River Water. The great advantage of having a constant and liberal water supply, such as is offered by large rivers, is unfortunately generally overbalanced by the liability to pollution of the stream through sewage from the towns and cities on its banks, as well as from the refuse from tanneries, slaughter-houses and factories of every kind that spring up along its shores. The pollution of English rivers by such means has long been well known. The Merrimac river in Massachusetts, which receives the sewage and refuse from numerous large manufacturing towns; the Schuylkill river, which supplies Philadelphia; the Hudson river, which receives the sewage from nearly all the towns upon its banks—are instances of American streams used for drinking water which are constantly polluted in this way.

It has been claimed that any large stream will purify itself after flowing from six to twelve miles, owing to the processes of oxidation and sedimentation continually active in its waters, and that these, with the immense dilution of mineral or organic matters incident to a large stream, are sufficient to free it from danger as a source of drinking water. It is true that mineral matters thrown into a river may be largely deposited in its bed, or in a large stream may be so highly diluted as not to be apparent

even by chemical tests of the water. According to the Reports of the Massachusetts Board of Health, this is the case with the river Merrimac, into which several large towns above Lawrence turn their sewage, and factories empty their refuse. Chlorine, for instance, which is thrown into the Merrimac in large quantities from factories above Lawrence, cannot, nevertheless, be detected in the water below that point, and judged from the standpoint of chemical examination alone, the river is nowhere very bad.

Notwithstanding this fact, the percentage of typhoid fever in Lawrence is higher than in most other Massachusetts towns, and expert sanitarians attribute this entirely to the fact that the city drinking water is taken directly from the river Merrimac, which, as has been said, is known to be highly polluted with sewage.

The case of the Croton water supplied to New York City is an example of water excellent and pure in its origin which is constantly exposed to sources of contamination on its shed. On this watershed, occupying a space of 377 square miles, there were, in 1891, 1,897 privy vaults, 682 barns and stables, 4 slaughter-houses and 5 cemeteries; while about 20,000 cattle graze and live on this area.

In the light of experience in other localities it is easy to conceive how a few cases of Asiatic cholera occurring on this watershed, or of typhoid fever, might

be the means of distributing the disease over the entire City of New York.

Even with the immense dilution of sewage incident to a large river, the chance still remains that a number of germs of disease which are liable to be present at all times in the sewage of a large community may reach us, and there is an equal chance that they may escape deposition in the river bed.

A river or other water, therefore, once known to have been polluted with sewage, is not fit for drinking purposes without special purification, by means to be described later.

Frankland has stated that there is no river in the United Kingdom long enough to purify its waters spontaneously if they have once become contaminated with sewage.

Ponds and Lakes. Water from ponds and lakes, if uncontaminated by sewage, generally offers an excellent source of drinking water. These lakes and ponds are the natural reservoirs for the small streams of the region, and are, from commercial reasons, less liable to contamination than rivers. They are, however, very subject to the growth of vegetable organisms, which may during decomposition give a disagreeable taste and odor to the water. A fishy taste may be given by the species belonging to the blue-green algæ (of the sub-order named Nostocs), while a cucumber taste in the Boston water supply was found to be due to the presence and decomposition of a fresh-water sponge, named

spongia. The remedy proposed has been the covering of the reservoir to preserve it from the sun and light, the absence of which prevents the growth of such algæ. The spongia is said to be the favorite food of the swan; and it has, therefore, been suggested that these birds might be introduced into lakes affected with the cucumber flavor. Artificial ponds are made by damming up one or more streams of a locality, and the level of natural lakes and ponds is also increased by this means. When the water of a lake is collected from an uninhabited region it is generally very pure, although it may be highly colored from the soil through which it flows. A pond or lake which receives its water from streams flowing through an inhabited area is liable to contamination, and should be purified before drinking, by means which will be described later.

Springs and Wells represent the underground water from varying depths, and are generally wholesome drinking waters or otherwise according to their depth and the presence or absence of contamination of the soil in the neighborhood. A shallow spring is one that comes through permeable soil, gravel or sand, from a limited distance. As the soil is an excellent filter, the water will be pure if no surface contamination has injured it. If the soil in the neighborhood, however, is constantly polluted with animal refuse, excreta, or foul water, a shallow spring may be contaminated in this way. A shallow well in a similar locality, especially if not properly roofed in, and covered at its mouth to

prevent surface contamination, is open to the same dangers. A deep spring generally issues from an impermeable strata of rock, and, unless willfully polluted at the surface, offers clear and wholesome water. Mineral springs are not referred to.

Wells. As wells offer the most common source of supply outside of cities, their location and preparation call for the greatest care. In the average country house the well is in close proximity to and frequently below the privy. The latter is probably a pervious structure of wood, permitting easy leakage of its contents into the soil beneath, which for many feet is completely saturated with sewage. This constant saturation interferes with the beneficent work of the bacteria in purifying soil, which otherwise would go on, for their capacity is literally overworked under the circumstances. If the soil between the well and the privy be of a pervious nature, constant percolation goes on from the privy contents into the bottom of the well. Rains might increase this impurity, if the passage between the two were not a direct one, by driving more fluid through the subterranean passage-way. On the other hand, if the passage were direct, rain pouring into the well would temporarily improve, by diluting the well water. Frankland tells us that the Holy Well at Mecca has several times as much animal matter as the same volume of London sewage! The contamination of well water from gas-works one thousand feet distant has been recorded. It

has many times been proven that typhoid fever has been acquired by drinking water from wells polluted with sewage containing this germ.

It should be noted that sewage-polluted water is generally pleasant to the taste, owing to the chlorides and other salts present; and, moreover, that clearness, a sparkling appearance, and an agreeable flavor in a water are compatible with a high degree of contamination. Also, that the presence of bacteria in numbers even as high as two millions per cubic centimetre does not impair its transparency. Therefore, transparency or an agreeable flavor are no guarantee whatever that a water is fit for drinking purposes, unless it is also known that is free from the danger of contamination by sewage.

To prevent contamination from the soil, the stone and brick lining of wells should be properly cemented from top to bottom, so that all the water that enters the well may have the advantage of filtering through the thicknesses of soil at the bottom. The surface of the ground for a few feet around the top of the well should also be paved and cemented to prevent surface water from passing into its mouth, and the ground immediately about the well should be raised above the general level, for the same reason.

The mouth of the well should also be covered to prevent substances being thrown or falling in, and a pump to raise the water is better than a bucket, because the former requires the covering of the well.

The situation of the well must be chosen with reference to putting a wide distance between any barnyard, refuse heap or privy, and must never be below the level of any such structure.

Tube Wells or driven wells are made by forcing an iron pipe with a pointed end into the ground, the lower end of the pipe being perforated with numerous holes, through which the water enters. Extra lengths of piping are added according to the depth of the well, and by means of a pump at the top the water is raised. Driven wells are generally made in partly pervious strata, such as clay. Artesian wells are made by driving similar iron pipes into impervious rock, generally for a considerable distance in depth. The water in driven wells is generally agreeable; its purity depends upon the absence of soil contamination. The depth of the well may vary from thirty to one hundred feet. Water from artesian wells, however, is liable to be mineralized, and is also frequently too warm for drinking purposes. An artesian well in Louisville, Kentucky, having a depth of over two thousand feet, bears water with a temperature of 76.5° Fahrenheit. Fish and certain plants have also appeared in water from such wells.

Tube Gang Wells are made by driving two or more parallel rows of tubes, and collecting the water in a central chamber, or through a large tube pumping it to the surface. Such a well in Brooklyn supplies nine millions of gallons daily. In using such wells storage

tanks are necessary, as the machinery by which the wells are run may get out of order, and the supply be temporarily cut off.

THE QUANTITY OF WATER REQUIRED.

A healthy adult requires from 70 to 100 oz. of water daily for the processes of nutrition; about one-third of this is contained in food, the remainder is taken in the form of liquids. The amount required for cooking is about half a gallon per day, and for personal ablution the amount varies with the habits of the individual. A shower-bath requires from 3 to 6 gallons of water. A general bath from 38 to 60 gallons, depending upon the tub. Water-closets require about 6 gallons per head, daily. To these estimates we must add the amount necessary for household cleaning, for animals, and for trade purposes. In cities, estimate must always be made for fire departments. Thirty-five gallons per head per day is the least that is compatible with these requirements, and more is desirable.

The allowance in most American cities is much more generous than this. In 1876 that of New York was 100 gallons per capita, but is now somewhat less, being about 85 gallons. Foreign cities, as a rule, provide less. The waste in some American cities is extremely great. The St. Louis Report of 1874 showed a waste in that city equal to four million of dollars for ten years.

THE CONTAMINATION OF WATER.

Practically, absolutely pure water is never found: that is, water with a composition of H^2O. Rain-water, as we have seen, dissolves out the gases in the atmosphere, and washes down other impurities. Springs and wells may be polluted with organic matter or may naturally contain minerals in excess, and rivers are almost certain to be highly charged with organic impurities from the towns on their banks. These impurities are, however, of very different degrees of importance, and their sanitary significance varies greatly with their origin.

For instance, the finding of iron or of lime in a water might strictly be classed as an impurity, but their presence in the water would not suggest any danger to health in the quantities usually found. On the other hand, the presence of bacteria in unusually large numbers would, in the light of our present knowledge of water supplies, suggest that sewage had found its way into the supply.

The Impurities of Water may be (1) *inorganic*, *e.g.* the result of mineral springs, as iron, calcium, potash, silicic acid, etc. These substances are not desirable in drinking water, as they may render it medicinal, but they are not poisonous or generally harmful in the proportions commonly present. Certain inorganic substances may have, however, a sanitary significance, on account of their origin only, not because they are

in themselves harmful. These are salts derived from the decomposition of organic matter in the water. Most organic matter is composed of carbon, hydrogen and nitrogen, with or without other elements. When this organic matter is exposed to oxidation in the soil, the carbon is generally first oxidized; then the hydrogen passes off in the form of water, and the nitrogen is one of the latest of the group to be oxygenated. Some of this, combining with the hydrogen, makes ammonia, whose bases are generally the first product of oxidation of organic matter in the form of nitric or nitrous acids. The nitrogen in these acids combines with bases in the soil, *e.g.* potassium, sodium, calcium, etc., and forms nitrites or nitrates, according to the amount of oxygen present. If the organic matter is completely oxidized, a nitrate results; if this oxidation is interrupted, or if, as we may say, we have caught the organic matter before its complete oxygenation, a nitrite is the result. In other words, ammonia, or nitrates, or nitrites found in water indicate the presence of organic matter which is undergoing decomposition. This organic matter may be vegetable or animal; the simple presence of these products of the decomposition of organic matter is not an absolute indication of its origin. The danger to the drinker depends upon the origin, which chemistry alone is unable to decide.

Sewage contains a large amount of organic matter of animal origin, with innumerable bacteria, also chlo-

rides in excess, as well as phosphates, sulphates and other salts. Water, therefore, which is contaminated with sewage, generally shows traces of such contamination in the products of organic decomposition already referred to, viz., ammonia, nitrites, nitrates; while chlorides, phosphates and other salts will also be present. Sodium chloride in water is sometimes due to the nearness of the ocean, or to the percolation of the supply in question through salt strata. Ammonia in wells may be due to rain-water, which, as we have seen, contains this gas in solution dissolved from the atmosphere. Artesian wells at a great depth also often contain free ammonia. Nitrates may also be present in good water in small quantities. The detection of these inorganic impurities in water generally indicates that the water is being contaminated with sewage; and where sewage is, there bacteria are, and under certain conditions these may be of a pathogenic nature.

It is not possible to establish a standard of purity of water based on chemical examination. The theory of to-day regarding the harmfulness of water is that this is due to the presence of pathogenic micro-organisms in the water, and that "the results of chemical analysis have their value in the light that they throw on the quality of water from the standpoint of bacterial contamination."

(2). The impurities may be of *organic* origin, *e.g.* small living organisms, bits of tissue from

animals, eggs of parasitic worms, spores, infusoria and bacteria. Some of these may be directly harmful in themselves, as certain pathogenic bacteria and eggs of parasites; while others are not harmful in themselves, but are important because they suggest the contamination of the water with sewage.

By far the most important of this list, already referred to as being the cause of the spread of certain diseases, are the bacteria. Most water as found for drinking purposes contains bacteria, as has already been said in the chapter on bacteria, although in pure spring water they may be absent. More than two hundred different forms have been studied in water, which for the most part are harmless, and, in fact, may serve us the good turn of destroying other organic matter present in the water. Many of these water bacteria are ærobic, others are anærobic, some are phosphorescent. They are generally more numerous near the shores of lakes, rivers, etc., than in the centre of these bodies of water. As a rule, these water bacteria multiply very rapidly in water. Cramer, of Zurich, found that the bacteria in a specimen of the city water increased twenty-seven thousand times in a few days.

The bacterial contents of different waters normally varies, both in number and kind of germs. Most waters may, therefore, be said to have their normal mean number of bacteria, which is not necessarily the same as that of other waters in the vicinity, and which

is only established by a long series of observations. This mean may be disturbed by natural causes or by sewage contamination. Varieties in sewage are exceedingly numerous. Dunham found that bacteria in applied sewage averaged 193,000 per cubic centimetre. The water of the river Seine above Paris averages 300 per cubic centimetre. Within the city limits, after sewage has been poured into it, bacteria increase to 200,000 to cubic centimetre. Prudden found in the Hudson river, above Albany, over 2,000 to cubic centimetre. The Croton water (1886–1890) averaged 319 to cubic centimetre, (largest number, 1,950—smallest, 20).

Bacteria may be present in excess without impairing the transparency of a specimen of water, one and one-half millions in a tablespoon not affecting one specimen.

In general, unpolluted streams contain fewer bacteria, — polluted streams, more. Water from canals may average from two to forty millions per cubic centimetre. The hygienic import of these facts is evident. Two of the principal epidemic scourges of the world, viz., typhoid fever and cholera, have been proved to be disseminated mainly through water contaminated with sewage. In 1885 a notable epidemic of typhoid fever in Plymouth, Pa., was caused by the contamination of the town water from the excreta of a typhoid case. The patient was ill in the winter; the excreta was thrown out upon the snow on the bank of a stream, about forty feet from his house. Some weeks after-

ward a thaw began. The snow was melted and carried into the stream which communicated with the town supplies, through which the infection spread to over one thousand people (1,104 persons were attacked by the disease, of which 10.3 per cent. died). A famous epidemic of typhoid occurred in the village of Lausen, Switzerland, from the contamination of a spring with the excreta of a patient ill with typhoid fever. Numerous instances are on record of similar casualties due to the same cause. An epidemic of typhoid in the cities of Lowell and Lawrence, Mass., in 1890, and the high death-rate from that disease in those cities, as well as that of Philadelphia, Chicago, Albany and others, is traced to the known contamination of their drinking water with the sewage of their own or neighboring cities.

The origin of cholera epidemics, both in Asia and in Europe, has uniformly been traced to the contamination of drinking water with the bowel discharges of cholera patients. The epidemic in Hamburg in 1892 is the latest notable instance of the kind, the epidemic in that city being due to the drinking of the Elbe, contaminated with cholera discharges. The city of Altona, practically a suburb of Hamburg, drank the water of the Elbe *after filtration*, and had only about one-sixth of the cases present in Hamburg.

Pathogenic germs, unlike ordinary water bacteria, do not appear to find a good breeding place in water. They live there for some time, but they do not mul-

tiply. The bacillus typhosus has been found in certain waters.

Koch found the cholera germ in a tank of water in Calcutta, where he was sent to investigate the origin of a cholera epidemic, and learned that some natives had washed the clothes of cholera patients in the tank. Nikati and Rietsch found it in the water of Marseilles harbor.

Organic matter, such as bits of tissue, muscular or otherwise, is only of importance as indicating that the water has received animal refuse, the presumption being fair that if it is liable to such contamination it is probably liable to sewage contamination. The eggs of tapeworms or threadworms may be found in water improperly supervised. The eggs of the anchylostonum duodonale, a small parasite which occupies the upper part of the intestines, whence it draws blood, have been present in certain waters in Egpyt and Switzerland in enough numbers to produce an epidemic. They induce a high grade of anæmia. Spores, infusoria, etc., are occasionally present.

Algæ may be of importance in waters of ponds and lakes, by reason of the bad odors or taste they give to water. Those belonging to the species of Nostocs give a fishy taste to water, and others give a cucumber taste. An examination of the locality of the water supply, and its nearness or otherwise to sources of contamination will often render a chemical or biological examination unnecessary. When one

knows that sewage is poured into a river, it is not necessary to examine the water to find out that it is contaminated. Neighborhood to a barn-yard heap, or the usual propinquity of the privy to the well, afford equal reason for suspecting contamination.

DISEASES WHICH ARE TRACED TO IMPURE WATER.

Enough has been said on the subject of the transmission of typhoid fever and cholera by water. These two diseases may be called pre-eminently filthy-water diseases. *Diarrhœa* may be due to the presence of decayed vegetable matter in water, fine scales of mica, or a large amount of sulphuretted hydrogen. Bacteria, not necessarily typhosus, but of varied kinds, and when present in great numbers appear to cause diarrhœal difficulties. The amœba dysenteria is believed to be the cause of dysentery, and may reach drinking water by the same means as does the typhoid or other germ, viz., by contamination of well or other supply with the bowel discharges of the patient. *Dyspepsia* may be caused by the presence of certain salts in excess, *e.g.* calcium sulphate, calcium chloride or magnesia salts, and these may also cause constipation as well as diarrhœa in some persons. Water carrying lead in solution will produce the characteristic symptoms of lead poisoning if habitually drunk. The habitual use of water containing from one-tenth to one-twentieth grain of lead per gallon may be attended with danger. One of the ex-royal families of France suffered from

this affection from water containing one grain per gallon. Evidence is lacking that goitre is caused by water containing lime or other salts in excess, although the affection appears to be more common in regions with limestone or magnesium strata.

The drinking of marsh water appears to have some influence in inducing malarial affections.

THE PURIFICATION OF WATER.

From what has been said it is evident that river waters and all others liable to contamination should be subjected to purification before being used for drinking purposes. Experiments have shown that the purification of drinking water on a large scale may be practically accomplished by filtration through sand, arranged in layers of increasing fineness from below upward, through which the water slowly percolates. This is known as a filter basin. It is built of masonry, and may have an area anywhere from 20 to 150 thousand square feet. In arranging the filter-bed drains are first laid on the floor of the basin of brick or stone. Then follows a layer of stones four to six inches in diameter, the next layer is of smaller stone, followed by successive layers of coarse and fine gravel, and finally, layers of coarse and fine sand. Water filtered through such beds for the first few days will only be slightly, if at all, purified, and it is only after a little time has elapsed that the bacteria and organic matter of the water begin to disappear. This they

will do until, under good conditions, as many as 99 per cent. of the bacteria and all of the organic matter have disappeared from the effluent.

This process of purification is due to the action of the bacteria which are in the water, which require time for the formation of the slime-pellicle which is the filtering agency in which they rest while carrying on their nitrifying functions. This has been already described under Soil as a Filter. The speed of the downward passage of the water, which should stand at about a level of four feet on the filter basin, should be slow, not exceeding one hundred millimetres per hour. Even under the best filtration all bacteria are not removed, therefore sand filtration will not give absolute protection against infection. In all cases the water from public filters should be periodically examined to test its purity, and this especially during the prevalence of an epidemic. Settling basins, in which the water first deposits some of its impurities by sedimentation, are used in conjunction with the filter basins. These basins are in very general use in Germany, France, England, etc. Every acre of surface of these filter-beds will filter two millions of gallons per day.

The Sterilization of water on a large scale has been projected, but has not yet been introduced into American cities. A few cities and towns in France have introduced the use of a sterilizing apparatus, which has been successful.

Chemicals, such as alum, salts of iron, etc., have

been used for the clarification of turbid water. The alum (in quantity one ounce to every forty gallons of water), acts mechanically by entangling suspended impurities in its meshes, and oxidation of the organic matter also occurs to a limited extent, but this process cannot be depended upon to destroy bacteria, and therefore is not reliable for the purification of water from suspected sources. The alum also may affect digestion unfavorably.

The Distillation of Water renders it free from noxious substances, acids and alkalies.

Purification of Water for Domestic Use. The boiling of water for thirty minutes is the practicable method of household purification, as all germs of disease are thereby destroyed. Hard water is also softened by boiling, as the escape of the carbonic acid which occurs during the process liberates the lime which is deposited in the vessel. Boiled water may be aerated afterward if too unpalatable, or a small portion of distilled carbonated water (for sale by all druggists) may be added. Domestic filters, such as are generally in use, are not only ineffectual as purifiers, but actually add to the impurities of the water passing through them. Such filters are generally made of quartz, charcoal, sponge and other substances, and are screwed on the faucet. The larger suspended impurities are strained out, but the bacteria can easily pass through the coarse meshes of these filters so long as they are free, and when the spaces become filled with dirt many

of the bacteria remain behind in the filter, where they multiply to an extraordinary degree, so that in time, water flowing out of these filters is far more impure than when it entered them. The only filters which appear to be successful in removing germs are made of porous porcelain; but such filtration to be effectual must be extremely slow, as high pressure will force the bacteria through. These filters are somewhat fragile and are also expensive. Fig. 5 shows such a filter in position.

FIG. 5.
PASTEUR'S DOMESTIC FILTER.

B is the main case, nickel-plated, screwed to the faucet through which water from the main enters at *A*. *C* is the porcelain filtering tube. *D* is a rubber washer to hold the tube in position and prevent leaking. *E* is a cap screwed to the main case *B*, permitting the filtered water to pass through the orifice *e*. The water passes, under pressure, to stopcock *A*, into case *B*, with no chance of exit except through the pores of the porcelain tube *C*. This it does, passing into the tube, and thence out through the orifice *e*, while all deleterious matter remains on the outside of tube *C*.

The Softening of Water on a large scale is affected by Clarke's process, which depends upon the addition of lime in large quantities. The hardness of water is due to the presence of earthy salts, generally carbonate of lime and sulphate of lime and magnesia. The former is de-

posited in boiling, and is known as the removable hardness. The other is not removed by boiling, and is called the permanent hardness.

Ice. It was formerly believed that freezing water purified it, no matter how impure it might have been. Experiments made by Prudden to determine this by freezing living bacteria, have proved that many bacteria withstand freezing, and that they may be preserved alive in ice for many weeks, possibly months. This is true of the bacillus typhosus, as well as of other bacteria. It is evident, therefore, that ice cut from sewage-polluted streams may be equally dangerous with impure water. Cases of typhoid fever have been traced directly to such impure ice. As it is difficult to discriminate in the cities between the ice supplies, it is desirable for drinking purposes to make use of ice artificially made from distilled water, as is done in New York, Philadelphia and elsewhere. Such ice is now manufactured at as low cost as natural ice. In natural ice recent experiments by the Massachusetts Board of Health have also shown there is a great deal of choice. What is known as clear ice was found to contain only a small per cent. of the organic impurities of the water from which it was made, not exceeding over 6 per cent., while snow-ice contained nearly as many bacteria as the waters from which it is made, or 81 per cent.

The origin of snow-ice is as follows: After ice has begun to form a change in temperature may bring

a fall of snow. This hinders the further formation of the ice by preventing radiation from its surface, and so threatens to spoil "the crop." To prevent this, small holes are often cut in the ice through which the water wells up and flows over the top. Much of the air is expelled, and the whole freezes, forming a whitish layer, due to the presence of air in the snow. The operation is known as bleeding the ice—and such ice is called snow-ice. It will be seen that if the water from which the ice is formed is impure (as in sewage-contaminated water) this operation will add fresh impurities to the ice. Examinations have proved that snow-ice contains many more living bacteria than ordinary clear ice. Snow-ice should therefore be avoided in ice from questionable sources.

CHEMICAL EXAMINATION OF WATER.

The chemical examination of water may be either *qualitative* or *quantitative*. The former, under ordinary circumstances, will be sufficient to form grounds for an opinion as to the probable purity of the water from the chemical standpoint, and will here be given. As already explained, chemical analyses give only an approximate idea of the purity of a given water. The danger of impure water lies in the presence of pathogenic bacteria, which cannot be detected by chemical means. Chemical examination, however, can show that the water is receiving more or less organic matter, and will indicate the various stages of its oxidation, and

when this is present bacteria will find abundant food. As this organic matter may be of human origin (sewage, etc.) it follows that pathogenic bacteria are liable to enter the supply at any time, suitable conditions being present.

Ammonia. Take a test-tube nearly full of the water to be examined. Add a few drops of Nessler's solution. A precipitate brown or brownish in color shows the presence of ammonia salts. A milky or curdy precipitate shows hardness of the water, which may interfere with the above reaction unless the water is softened.

Nitrites. Take a test-tube three parts full of the water suspected. Add five drops of pure sulphuric acid and five drops of a solution of potassium iodide (five grains to an ounce of distilled water). Afterward pour in a freshly-made starch solution. A blue tint indicates nitrites.

Nitrates. Put twenty minims of pure sulphuric acid into a very small test-tube. Add ten minims of the water to be examined. Then drop in carefully one drop of a solution of pyrogallic acid (ten grains to an ounce of distilled water, acidulated with two drops of sulphuric acid). A pink zone, or sometimes a delicate blue zone changing to amethyst and brown, indicate nitrates. This may disappear on shaking, but gradually returns, and is permanent.

Chlorides. Acidulate the water with a few drops of diluted nitric acid, and add in excess a solution of

nitrate of silver. Four grains of sodium chloride per gallon give turbidity. Good water should only yield a slight haziness. A distinct precipitate indicates that the water comes from a salt formation, from near the sea-coast, or that it is contaminated with sewage. The latter is certain if the water is soft.

Lead. Ammonium sulphide yields a black precipitate, not removable by hydrochloric acid.

Copper yields the same reactions with ammonium sulphide as lead, but with the ferro-cyanide test copper yields a brown precipitate.

In a *quantitative* analysis the total solids, the hardness, the chlorides and the organic matter represented by ammonia in different combinations are estimated.

MICROSCOPIC EXAMINATION.

By *microscopic examination* of a specimen we may find bits of muscular tissue, the eggs of tænia, ascarides, the oxyuris, spores, infusoria, algæ, etc. Striped and unstriped muscular fibre are considered evidences of sewage contamination. The water is collected in a clean bottle and allowed to stand for a few hours in a cool place to deposit sediment. The upper portion is then carefully decanted, and the sediment particles examined under low and high power of the microscope.

THE BACTERIOLOGICAL EXAMINATION.

This must be undertaken within two or three hours after gathering the sample, in order to obtain a cor-

rect idea of the number of bacteria present, as these multiply with extraordinary rapidity in water. The water to be examined should be received in a previously sterilized test-tube or bottle. A cubic centimetre of the specimen is then taken and mixed with a test-tube partly full of sterilized nutrient gelatine. After this has been well shaken, to insure the mixing of the germs with the gelatine, it may be poured into a sterilized Petri's plate. After a few days the germs will have developed sufficiently to show as white dots over the surface. Each colony is due to

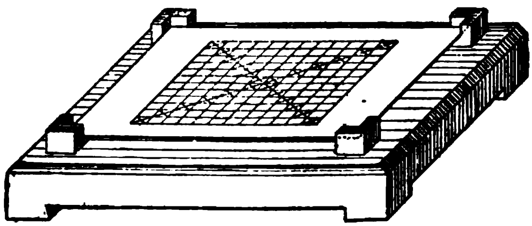


FIG. 6.—APPARATUS FOR ESTIMATING THE NUMBER OF COLONIES IN A PLATE CULTIVATION.

the presence of a single germ; *e. g.* ten colonies mean ten germs to a cubic centimetre. If not too numerous, the colonies are easily counted, and cultures may be made from them to prove the species. Wherever the colonies are very numerous it will be necessary, in order to count them, to make use of a glass plate ruled into squares or centimetres, arranged on a frame, so that it may be placed over the plate containing the cultivation. The number of colonies

present under one square is ascertained by means of a magnifying glass, and the observation repeated in five or six squares. From these the average per square is estimated and multiplied by the whole number of squares to obtain the estimate of the whole surface. (Fig. 6).

All instruments, pipettes, plates, gelatine, bottles, etc., are thoroughly sterilized before being used.

CHAPTER VII.

Food.

A broad definition of food would be any substance capable of playing a part in the nutrition of the body. This would include the oxygen of the air, and in a very real sense oxygen is of the highest importance to bodily nutrition. In its more limited sense, however, and the one which we shall use, food may be defined as any substance which is capable of oxidation in the body, and one that is voluntarily taken into the digestive canal through the mouth. Through the assimilation of food the temperature of the body is maintained, muscular and mental energy is evolved, and the daily waste of the body is repaired. This daily waste is estimated at $\frac{1}{24}$ of the body's weight, *i.e.* a person weighing 120 pounds would lose 5 pounds daily through the different channels of body-waste,—the lungs, skin, kidneys and bowels. Food stuffs have their sources in both the animal and vegetable kingdom.

In attempting a classification of foods, milk, which alone is capable of sustaining the human organism through its entire early existence, may be taken as a type, and in it we find representatives of all the elements necessary for nutrition, viz.:

(1) Nitrogenous elements, examples of which are albumin and casein; (2) carbohydrates, as sugar in the form of lactin; (3) hydrocarbons, or fats; and (4) mineral salts and water.

(1). *Nitrogenous Foodstuffs.* These may be of either animal or vegetable origin. They are taken into the body in the form of proteids, which is the only form in which nitrogen can be assimilated in the human body. The greater part of the human body—muscle, blood, lymph, etc.—is composed of proteid or albuminous elements; and the other interstitial fluids have a large percentage of these. There is also a certain amount of nitrogen in the form of urea (30 to 40 grammes, or 500 grains daily) and of uric acid (about .5 gramme, or 7 to 10 grains) excreted in the urine, with a few other nitrogenous substances. These are formed from the destruction of the proteids of the body, and their loss must be made good by the intaking of nitrogenous food. By this means what is called the nitrogenous equilibrium of the body is maintained. There is actually a slight surplus in the intake, as the amount excreted in fæces and urine is less than that taken into the body.

Proteids are composed of the following elements (Hoppe-Seyler):

O.	H.	N.	C.	S.
20.9	6.9	15.2	51.5	.3
23.5	7.3	17.0	54.5	2.0

It will be seen that proteids contain about 16 per

cent. of nitrogen and over 50 per cent. of carbon. There are two groups of nitrogenous bodies. The first is that of true proteids, a term applied to such as are of equal nutritive value and are capable of sustaining the nitrogenous equilibrium of the body. The second contains bodies of unequal nutritive value, which are not capable of performing the functions of true proteids. Of the true proteids we may mention *albumins* of serum and egg, *myosin* of muscle, *globulin* from the serum and yolk of eggs, as examples from the animal kingdom; while the leguminosæ and cèreals furnish it from the vegetable. Proteids are also obtained from the gluten of wheat and the fibrin of the blood, the casein of milk, and the vegetable casein of peas and beans.

(2 & 3.) *Non-Nitrogenous Foodstuffs.* These comprise *fats* and *carbohydrates.* Fats have a composition of $C^{10}H^{18}O$. They are both of animal and vegetable origin.

Animal Fats are found in mutton, beef, etc., in the yolk of the egg, in the bile and the brain.

Vegetable Fats are found in corn, oats, olives and various seeds and nuts. The different fats are known as stearine, olein and palmatine. *Stearine* is the hardest fat known, as it is solid at ordinary temperatures. It is found in most animal fats. *Olein* is the chief constituent of fluid fats, such as olive and linseed oils. *Palmatine* is a solid fat mostly from the vegetable kingdom.

Carbohydrates are principally derived from the vegetable kingdom in the form of various sugars and starches. They have a composition of $C^6H^{10}O^5$. The principal sugars are cane, grape, beet, glucose (sugar of starch) and honey. All of these sugars are eventually changed into grape sugar in the body before they reach the circulation.

The animal kingdom contributes sugar of milk; glycogen, found in the liver; and inosite, found in muscle and other animal foods. Cellulose, the indigestible fibre of plants, is also allied to this class.

Vegetable Acids. Although these belong to different chemical groups they may be mentioned together, since they all perform the same functions in the body; *i.e.* their salts are converted into carbonates, and they serve to preserve the alkalinityof the blood and other fluids of the body. Tartaric and citric acid are the most important members of the group. In addition, we have acetic, lactic, malic, oxalic acids, which are related to fatty acids.

(4). *Mineral Salts. Salts* of various kinds are absolutely necessary to the body. Among these sodium chloride, potassium chloride, phosphates of calcium, and magnesium and iron compounds are present; sulphates are of less importance; the carbonates of soda are chiefly derived from the acids.

Water is necessary for the proper carrying on of the bodily functions, and is mostly derived from that taken into the body in its own form, although a portion is

obtained in food and another portion from oxidation of hydrogen in the tissues. The functions of these elements are referred to later.

THE FUNCTIONS OF FOODSTUFFS.

Nitrogenous foodstuffs are pre-eminently constructive, they are the makers of energy, mental and physical. When animals are deprived of nitrogenous food they lose muscular power, and gradually become listless and torpid; while on increasing the supply they soon show increased aptitude for work, both mental and physical. As most of the essential organs and tissues of the body are largely composed of nitrogen, the withdrawal of this element would naturally be followed by lessened power. The absorption of oxygen in the tissues is also largely directed by nitrogen. Oxygen is required in the body in proportion to the energy and activity of its different component cells.

It is within the cell elements of the mucous membrane of the stomach, of the liver, of the lungs, etc., themselves mostly composed of nitrogen, that the chemical and vital activities necessary for life and labor are carried on. In proportion to the activity of these cellular (nitrogenous) elements oxygen is required in greater or less amounts, and accordingly the nitrogenous elements of the body are the *exciters of metabolism* in the body. A certain amount of heat is also produced by the activity of nitrogenous bodies, which may be called frictional heat.

Fats or hydrocarbons are also force generators, but have a special use as heat producers. Like proteids they form an integral part of the structures of the body. Fats are non-conductors of heat, therefore when present in the body as adipose they assist in maintaining its temperature. Chemically their composition shows unsatisfied relations of hydrogen and carbon. In carbohydrates the hydrogen and oxygen exist in proportions to form water, leaving the carbon to be oxygenated during destructive metabolism. In fats these proportions do not exist, therefore fats are more greedy for oxygen, and in their oxidation heat is produced in large amounts. Fats form also a reserve material upon which the body can draw for nourishment in disease or starvation, thus sparing the proteid in the master tissues of the organism. In hard labor they also are first utilized, to the sparing of proteids.

They do not incite metabolism as do proteids, and they cannot serve alone as an article of diet. Fat in the body is formed from albumin, as well as from carbohydrates. It is shown that for every 100 parts of fat given in the fattening of pigs, 474 parts are stored up; this fat can only come from the metabolism of albumin in the body. The fat in mothers' milk is also due to the breaking down of the protoplasm of the cells of the lacteal glands.

Carbohydrates are pre-eminently heat-producing elements; oxygenized in the body they form carbonic

acid and water, and are finally eliminated by the lungs and skin. They are changed in the process of digestion into glucose or grape sugar before they can be absorbed in the circulation, and therefore the entire class is spoken of generally (starches, sugars, gums, mucilage, etc.) as glucoses. Alone they are incapable of sustaining life; but although they are not constructive in the absolute sense of proteids — as unlike them, they do not form an integral part of the tissues—they are nevertheless necessary. Heat is an absolute essential to the human organism in order that all its chemical and vital activities may be carried on without limitation. The proteids do not furnish sufficient quantity for all these purposes, and fats and glucoses are therefore essential. Carbohydrates appear to be highly conducive to fat formation in the body, as they do not promote metabolism.

Salts of various kinds are necessary both as solvents and as maintaining respectively the required alkalinity or acidity of the different juices and tissues of the body. Calcium phosphates, also calcic carbonate is present in the bones and in (almost) every tissue. Potassium and sodium salts are present in the blood where they are required for its alkalinity. Sodium chloride is particularly lacking in vegetable foods. Phosphates, like chlorides, are peculiarly associated with proteids. Potash is present in the blood-cells, sodium in the plasma, and sodium chloride is the

source of the hydrochloric acid of the gastric juice. Potash is present in muscle. The lactates and tartrates are essential, their total absence in the diet giving rise to the constitutional affection known as scurvy. Bacteria and fungi die without earthy phosphates, and human beings suffer so from the complete withdrawal of salt that in certain countries the practice has prevailed of feeding culprits on saltless food.

Sulphates exist only in small quantities in the body. *Iron* is essential, and forms an important part of the hæmoglobin of the red corpuscle. It is contained in many foods, particularly animal.

Water, the universal solvent, is required in amounts additional to that formed in the body. It forms a large proportion of the tissues of the body (75 per cent.). It is lost to the body by evaporation from the skin, 1¾ pints daily, in feces about 4 ounces; by evaporation from the breath, 1 lb., and from the kidneys, 2¾ lbs.; and these losses must be made good. It dissolves food, aids in the circulation, lubricates tissues, and by its evaporation helps to maintain the temperature of the body at the normal. About 296 grammes are formed in the body by the oxidation of the hydrogen in the tissues, the rest is taken in as food.

QUANTITY OF FOOD REQUIRED.

The quantity of food required will vary with *age*, *sex*, *work*, *climate*, as well as with individual consid-

erations of health and disease, particularly as these regard digestion. It is impracticable to lay down an actual limit for individuals.

In aggregations of people, however, as in asylums, prisons, hospitals and other institutions, economic and other considerations make it desirable to have a basis for calculation of dietaries on a large scale.

It is established that proteids, water and salts are essentials. How far the other two classes of carbohydrates and hydrocarbons may be mutually interchangeable, *i.e.* whether we can make up for the loss of carbohydrates by adding more fats to our dietary, and *vice versa*, is not absolutely settled. Practically, the experience of mankind would seem to show that both should be included in a proper dietary.

Standard diets have been compiled by the following methods. A healthy individual is selected, and the exact amount of carbon and nitrogen required to preserve the equilibrium between the intake and the outgo is estimated.

Corrections for these results have been made by estimating the quantity of food eaten by large communities of individuals when at rest, at work, and in different occupations. Also by weighing the amount of food used by single individuals and then estimating the amount of combustible foodstuffs. *The average daily subsistence diet* of a man weighing 150 pounds

or 68 kilogrammes is estimated as follows (Smith and Playfair):

	Subsistence.		*Rest.*	
	Grammes.	*Oz.*	*Grammes.*	*Oz.*
Proteid,	66	2.32	100	3.52
Fat,	24	.84	50	1.76
Carbohydrates,	330	11.5	400	14.08
Salts,	14	0.5	....	....
	434	15.16	550	19.36

This diet, however, would vary with the strength of the individual.

Diet for a man weighing 150 pounds during work (Moleschott):

	Medium work.		*Severe work.*	
	Grammes.	*Oz.*	*Grammes.*	*Oz.*
Proteid,	130	4.59	140	4.94
Fat,	84	2.96	90	3.17
Carbohydrates,	404	14.26	434	15.31
Salts,	30	1.06	32	1.13
	648	21.67	696	24.55

Converting Moleschott's diet into terms of carbon, nitrogen, etc., we obtain

Nitrogen,	20.9	grammes, or	321	grains.
Carbon,	307.0	"	4,731	"
Hydrogen,	11.6	"	179	"
Sulphur,	1.8	"	28	"
Salts,	30.0	"	464	"

The water necessary is estimated as from 2,700 to 2,800 grammes, or 70 to 80 ounces, in addition to that formed in the body.

INFLUENCE OF AGE, WORK, SEX, ETC., ON DIET.

In increased labor, fats and proteids chiefly are increased. By work the living nitrogenous muscle is used up and must be replaced. Fats appear to spare its consumption to some extent, so that a man can work harder with a diet containing a moderate amount of proteids with an excess of fats than on the proteids with an excess of carbohydrates.

Sex. As woman's manual labor is generally less than man's, her diet is given as proportionately three-quarters to four-fifths that of man's.

During lactation a woman requires an increased amount of food, especially proteids.

Age. Children require proportionately more food, owing to the processes of growth. Proteids are necessary as constructive material.

The mineral salts, sodium, calcium, and the phosphates, are highly essential for the child, to favor digestion and assimilation. Their absence, aided by other unhygienic conditions, results in rickets.

The average proportion of nitrogenous to non-nitrogenous foodstuffs in the adult should be as 1:3.5 or 4.5 (Voit).

As regards the proportion of the two members of the non-nitrogenous foods to one another, viz., fat and glucoses, there is greater difference of opinion. According to Voit, the proportion of fat to carbohydrates in the daily diet ought not to be less than 1:9.

In the diet of the poor, carbohydrates are relatively increased because they are cheaper, as fat is mainly derived from animal food which is more expensive than vegetable.

Old Age. The bodily needs are greatly lessened in this period, as growth having ceased bodily activity (waste) consequently is at its minimum. Consequently an easily digested but nutritious diet is suitable for old persons, with a fair proportion of heat producers. Such a diet would include eggs, milk, the more digestible meats, with some fat, generally given as butter.

Climate. In cold climates where energetic muscular action is common, and heat production in excess is necessary, both fats and proteids are especially increased in the dietary; in fact, the total quantity of food is increased. In the arctic regions the Laplanders eat fat in the form of blubber, and obtain their proteids from whale's meat. They have little or no carbohydrates.

In warm or tropical regions fat is seldom eaten in any considerable quantity. Lean meat, rice, maize and bread form the staples, with fruits.

A Mixed Diet, i.e. a due proportion of nitrogenous and carbohydrate food, is universally believed to be physiological as well as economical. It would seem to be suggested, (1) by the organs of digestion, which are varied in their functions,—some digesting proteids almost entirely (as the stomach), others fats and starches. Experience has also proved that man is by nature

omnivorous. So-called vegetarians are seldom, if ever, consistent, making use of milk and eggs in addition to other foods, both of which are, of course, from the animal kingdom. (2) Calculations made to determine the amount of nitrogen and carbon required by man prove that he can obtain these amounts more easily with a mixed diet than when he is limited to one article of food, and with far less tax upon his digestive organs. For instance, taking bread and meat as examples respectively of proteid and carbohydrate foods, we find the average requirements of the laborer are nitrogen, 307 grains; carbon, 4,694 grains.

If he attempts to obtain all this from bread alone he will need to eat over four pounds of the article in order to obtain the nitrogen necessary. The proportions of carbon and nitrogen in bread, however, are such that this would give him an immense overplus of carbon to dispose of, for which his body has no use, and which would only overtax it to eliminate.

In the same way, attempting to live on meat alone he would find that he would have to consume 6.6 lbs. of meat daily in order to obtain the necessary carbon, while the nitrogen he needs could be obtained from about one-fifth that amount. The excess of proteids in this case would overtax the liver and the kidneys, and the diet would also be very expensive.

By using a mixed diet of bread and meat, however, he can live on 2.2 lbs. of bread and two-thirds of a pound of meat daily and be well nourished.

Dr. Stark, of London, in 1769 attempted various experiments in this direction, by confining himself to articles of diet which represented the various classes. He lived for 44 days on bread and water; for 29 days on bread, water and sugar; and for 24 days on bread, water and olive oil. His health, however, became so impaired that he died in consequence.

THE DIGESTIBILITY OF FOOD.

The actual constituents of a foodstuff do not necessarily determine its nutritive value, for this is largely proportionate to its digestibility. Cheese is highly nutritious, but in large quantities is not digestible for most persons, therefore is practically of less nutritive value than less concentrated food which can be more thoroughly assimilated. Day laborers, however, appear to make it serve as an important part of their midday meal without bad results, and peasants eat it in large quantities. In general, animal proteids are more digestible than vegetable, and the same is true regarding animal fats. Amongst animal fats the fat of milk is more digestible than that of meat.

Beef is in general the most digestible of any animal food. Fish is less digestible than meat. Among vegetables, the carbohydrates of rice and potatoes are the most digestible.

The actual time for digestion of foods must vary with each individual, as also with the preparation, cooking and other conditions; in general, it is from two

to five hours for a hearty meal properly cooked. Cooking softens the fibre of meat, and also the cellulose of vegetables, so that the gastric juice can come in contact with these more readily. By cooking meat certain flavors are also brought out, which add to its palatability and digestibility. The flavoring of food, both as regards bringing this out by cooking and also the addition of salt, etc., is an important element in its preparation, and should receive more attention in the household.

Imperfectly cooked meat is tough and digested with difficulty. Too much food will impair digestion, the undigested meal decomposes, and in the fermentation butyric, lactic, acetic and other acids are formed. This fermentation is especially liable to occur when too much carbohydrate food is taken. Vegetable foods contain the vegetable acids or their salts, and these may interfere with digestion. This acidity may be increased by the ingestion of fats in excess, which are also split up in part into fatty acids and glycerine and may give rise to intestinal indigestion.

The Reaction of food is, as a rule, slightly alkaline, and this alkalinity stimulates the flow of the gastric juice. If food is too acid it will hinder digestion. Sleep is believed to diminish digestion.

Cooking. In addition to the softening of meat fibre and the cellulose of plants already mentioned, which increases the digestibility of food, the raising of the temperature of the food by cooking is also an aid to

digestion. If taken cold the food would have to be raised to the internal temperature of the body before digestion could begin. Cooking is also a preventive of disease, as most of the parasites which may infest meat, as well as the bacteria which may be on the external surface of foods, are killed by being subjected to the temperature required for roasting or boiling.

Vegetables for the most part absorb a large amount of water during cooking, and give up salts to the water, which are lost if this be in excess. They should therefore be cooked in as little water as possible.

Cooking coagulates part of the proteids in vegetables, some remaining unchanged; while starch is dissolved by reason of the rupture of the starch envelope and the escape of its granules. In the boiling, starch is converted into "soluble" starch, which is a more digestible form.

Animal food, unlike vegetable, has its flavor improved by cooking. It loses instead of gaining water in the process, and also loses some salts, extractives, etc., particularly in boiling. In cooking meat for eating the external parts should be coagulated as soon as possible, so that the juices of the meat may be retained. In boiling, meat should be immersed for five minutes in boiling water for the above purpose, and then should be cooked slowly at a temperature about 70° C., in order to soften the interior more gradually. The temperature should not be above 70° C., because

above that most of the proteids coagulate so firmly as to become indigestible. Gelatin is formed in cooking chiefly from the connective tissues of foods.

DISEASES CONNECTED WITH FOOD.

These will be discussed in detail in connection with the different articles. In general, we know that tuberculosis, typhoid and scarlet fever and certain other affections less definite may be carried in milk; that meat from tuberculous animals may also transmit tuberculosis to human beings, and that certain parasitic diseases, notably trichiniasis, as also the presence of tapeworm in the human body, are due to diseased meat containing the respective parasites of these diseases. Diseases through vegetables and fruit may be carried by the lodgment of infectious bacteria upon the surface of the article in question if it is eaten unwashed. Ergotism is due to eating diseased wheat.

An excess of food is probably the cause of much ill health, both in childhood and mature life. An excess of albuminates overtaxes the digestive organs, notably the liver and also the kidneys, in their excretory functions, and increases the gouty diathesis. An excess of carbohydrates gives rise to fermentation with the production of gases, flatulence, and even more serious symptoms of indigestion. It is also badly borne by those having a tendency to gout and rheumatism.

A *deficiency* of food in general predisposes to all exhausting diseases, to anæmia, and nervous exhaus-

tion. A marked deficiency in fat is believed to predispose to scrofulous conditions, tuberculosis, etc., that of starches is borne longer if fat be given instead. Scurvy is induced by the absence of the various salts contained in vegetables and fruits. The history of plagues has often been that of fevers following famine.

PARTICULAR ARTICLES OF FOOD.

Meat. This is chiefly a proteid and fatty food. It is also especially rich in salts, but has almost no carbohydrates. The chief proteid is myosin, which is soluble only in saline solutions or dilute acids and alkalies, and is coagulated by heat below 100° C. Other proteids are serum-albumin, and globulin derived from the blood of meat. Gelatin and elastin are formed in the process of cooking. Fat exists in different proportions in meat, according to the animal, pork having in general the greatest quantity. It is composed of stearine, palmatin and olein.

The *salines* found in meat are principally potassium and phosphoric acid. Magnesium, calcium, sodium and chlorine are in less quantity.

The *carbohydrates* are represented by glycogen, and inosit is present, but only in very small amounts. After death this is mostly changed to grape sugar.

The *extractives* of meat are nitrogenous, crystalline bodies which constitute the stimulating principles of beef tea and broth; of these creatin and creatinine constitute the principal.

The following table from König gives the percentage composition of different kinds of meat:

	Water.	*Nitrog. Subst.*	*Fat.*	*Nitrog. Free Extractives.*
Beef, very fat,	53.05	16.75	29.28	....
" lean,	76.37.	20.71	1.74	....
Veal, fat,	72.31	18.88	7.41	.07
" lean,	78.84	19.86	.82	....
Mutton, very fat,	53.31	16.62	28.61	.54
" medium,	75.99	17.11	5.77	....
Pork, fat,	47.40	14.54	33.34	....
" lean,	72.75	20.25	6.81	....

It should be noticed that the entire amount of nitrogenous substances here calculated are not available for nutrition, *i.e.* of the 20 per cent. and over found in lean meat, part is gelatin and elastin, which are not by any means of the same nutritive value as proteids. Parkes gives the total proteids of beef and mutton as 17 per cent., of which 13 per cent. are useful; others give the percentage somewhat higher.

The flesh of young animals contains more gelatin and less proteids than that of mature animals.

Good meat has a firm feeling, is of a bright red color streaked with fat, and is not unduly moist. A knife plunged into it should not come out wet, nor should it have any odor. Meat beginning to decompose has a purplish hue, and sometimes exudes moisture, and has an odor characteristic but difficult to describe.

Diseases from Meat. Meat may give rise to symptoms of disease, because (1) of its putrefaction after it

has been killed; or (2) because it is taken from a diseased animal. Individuals have frequently been seized with acute symptoms of illness, mostly referable to the digestive organs, after eating flesh or fish which has begun to putrefy. These changes occurring in meat are due to the presence of putrefactive bacteria feeding on proteid bodies, which in breaking up give rise to the production of certain crystalline products called ptomaines, also cadaveric alkaloids.

Certain of these alkaloids have been isolated and injected into lower animals, and such injections have been followed by various symptoms of poisoning, sweating, diarrhœa, and a great increase in all the secretions. In some cases the heart is accelerated and finally stops; another alkaloid has been found to paralyze the ends of motor nerves. In human beings the symptoms are generally nausea, vomiting, abdominal pain and diarrhœa, with more or less prostration.

Fatal epidemics of diarrhœa have been reported at different times, due to such causes. In one instance the eating of ham was the cause, and it was demonstrated by Ballard and Klein that the disease was due to a specific bacillus.

Meat may also be poisonous from the dosing of the animal with drugs, as arsenic or antimony, previous to slaughtering.

It has not been proven that meat taken from animals dying of general diseases, as epidemic pleuro-pneumonia, is necessarily poisonous, but it would be

better, on good general principles, to forbid the sale of such flesh.

Parasites in meat are a source of spread of disease in man. This is particularly true of those giving rise to *tapeworm* and to *trichiniasis*. The *pig* is especially infested with both of these parasites.

The *cysticercus cellulosæ* is the embryo of the tapeworm, and is found scattered through the flesh of the diseased pig in the shape of little, round, whitish bodies, giving it what is called a "measly" appearance. They may generally be seen on the under surface of the tongue. They are killed by a temperature of 57–60° C., but are not affected by smoking or salting. The cysticercus occurs in beef and also in mutton. Fig. 7 (after Birch-Hirschfield) shows these little bodies in muscle of the pig.

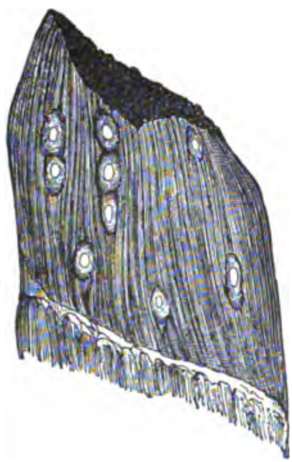


FIG. 7.—"MEASLY" MEAT.

Trichina are tiny encapsulated worms which are found between the bundles of muscle fibre. When such flesh is eaten, these eggs become freed in the alimentary canal and develop, and the embryo pass through the intestinal canal and migrate to other muscles. It is this migration which gives rise to the intense pain in

the muscles characteristic of this disease. Fever and other symptoms also accompany it. Trichinæ are killed by a temperature of 63–70° C. Fig. 8 shows the young muscle trichinæ coiled up between the muscle fibres.

FIG. 8.—YOUNG MUSCLE TRICHINÆ.

Tuberculosis is a very common disease of cows and also may occur in other animals, and may be transmitted to man through the agency of diseased meat and milk from such animals. Further reference to this point is made under Milk and Meat.

Numerous experiments have proved that tuberculosis may be communicated to lower animals by feeding them on the flesh and organs of tuberculous cattle.

Cows are particularly liable to this disease. Sheep are less liable. Large numbers of cows in dairies in New York State, New Jersey and elsewhere have been found to be the victims of this disease.

The New York State Board of Health has now (1894) over 20,000 cattle under official ban for this disease, waiting for means to indemnify the owners for their destruction.

This and the danger of other infection of meat show clearly that inspection of all slaughtered cattle should

be enforced by law in every State in order to prevent the sale of diseased meat. Private slaughter-houses should therefore be abolished and the responsibility for inspection be thrown upon public officers. Household protection lies in the thorough cooking of meat, as baking or boiling at the usual temperature suffices to destroy all parasites; but meat is frequently eaten under-done, and sometimes, for invalids, is scraped raw; and these customs cannot be devoid of danger unless meat supplies are controlled by the government.

MILK.

The importance of milk as an exclusive diet for the infant, and as his partial food for many years afterward, makes it necessary that its normal constitution should be preserved in its purity.

All forms of milk are emulsions of fat in a solution of albumin, sugar and salt.

Chemical analysis of cows' milk gives the following: Specific gravity, 1029–34. Proteids, 4, in the form of casein and albumin, 3.7 per cent. fat (butter), 4.8 per cent. of carbohydrates in form of lactose, and .7 per cent. salts, with 86.8 per cent. of water. Reaction alkaline. The proportion of nitrogen to non-nitrogenous elements is as 1:2. In human milk this ratio is as 1:4, which shows us at once that cows' milk is not a perfect food for infants, and must be diluted and otherwise changed to reduce it to the proportions of human milk proper for infants.

The salts of milk consist mainly of sodium, chlorides, potassium and calcium phosphates and iron. There is more potash than soda present.

Certain cows, as the Alderneys, give more butter than others. The long-horned animals are said to give more than the average amount of casein. As regards the differences in time of day the end of the milking at any time is said to be richest in casein, and evening milk yields more butter than morning. Cows fed with fresh fodder (grass) show a larger proportion of water in the milk, while dry fodder gives a larger amount of richness. Milk, as is well known, alters on standing. It is said to absorb oxygen and give off carbon dioxide, its quantity of fat is increased; later it becomes sour, by which it is meant that by the activity of certain micro-organisms, lactic acid is formed and milk-sugar is hydrated. Souring of milk is favored by a temperature of between 24° and 28° C., and also by thunder; it occurs easier in shallow vessels and in bottles not entirely full. A temperature of a few degrees above zero checks it, and boiling also destroys the ferment. When milk stands for several days the casein is reduced or lost, and odors occur due to the activity of butyric acid-forming bacteria.

Usually, saphrophytic bacteria are present in milk in considerable numbers. When in unusually large numbers these saphrophytes may induce digestive disturbances, particularly in children. Some city milk may yield as many as several million germs per drop.

Certain saphrophytes have the quality under certain circumstances of forming *ptomaines* out of the casein of milk, particularly when this has been flavored with vanilla. *Tyrotoxicon* is such a ptomaine and gives rise to gastro-intestinal symptoms similar to cholera. It has also been isolated from cheese.

Rarely, milk may be colored blue from the presence of a bacillus (cyanogenes), which is in itself colorless, but imparts that color to the milk. Such milk may give rise to irritation of the stomach.

There is probably no article in the food of human beings that has been so often the medium for transmission of disease as milk. Mr. Ernest Hart alone has collected and recorded 50 epidemics of typhoid fever, 15 of scarlet fever, and 7 of diphtheria, which he believes to be due to infected milk, with a total number of cases estimated at 48,000. Cholera should be added to this list, as well as summer diarrhœa, and infection from the bacillus tuberculosis is also one of the dangers to be feared.

These diseases are due to the introduction of specific pathogenic bacteria into milk through various agencies. 1. Contamination from the cow, either from constitutional infection on her part or from local disease of the udder. 2. Other sources, as the hands of the milker, dirty vessels or air from unclean or infected localities. 3. The watering of milk with water from a polluted stream, and the washing of vessels with the same water, are common means by which milk is infected. Typhoid

fever and cholera may be transmitted in this way. A recent epidemic of typhoid fever in Montclair, N. J., in which 115 cases occurred, with 13 per cent. of deaths, was traced to the contamination of the milk supply, due to washing the milk cans and bottles with well water which had been polluted, by leakage from the privy, with the discharges of a typhoid fever patient. Diphtheria is also carried by milk.

It is undoubtedly true that some cases of tuberculosis in children have been induced by drinking the milk of tuberculous cows.

Reference has already been made to the danger of transmission of this disease through tuberculous meat. As milk is not generally cooked before it is drunk, the danger of tuberculosis in this direction is even greater than from meat. It is to be avoided by cooking or pasteurizing milk, especially for infants, as referred to in paragraph on control of milk.

Milk is very Liable to Adulterations and certain manipulations which reduce its nutritive value and sometimes may interfere with its digestion, such as the addition of water, of salts, and of other less digestible fat than its own after the latter has been removed artificially. Salicylic acid, borax, soda and other materials are sometimes added to preserve the milk. Soda and borax have no influence in preventing the growth of bacteria; salicylic acid has a little more influence in that respect; but none of these preservatives are permissible, as they only hide the temporary

changes in milk which would otherwise warn the consumer against its use. Sour milk is a constant source of digestive disturbance in infants.

EXAMINATION AND CONTROL OF MILK SUPPLY.

An excess of water may be detected by testing the specific gravity. This is taken in a *lacto-densimeter.* The addition of water lowers the specific gravity. According to Letherby, 10 per cent. water lowers it to 1027; 50 per cent. to 1015. Cream is often removed from the milk, and water is often added, this is called *creaming* the milk. Good milk is from 1028 to 1034; creamed milk from 1033 to 1037. The amount of cream in milk is estimated in a *creamometer* graduated in 100 parts. This should be filled with milk and allowed to stand twenty-four hours. The cream should measure 10 to 15 volumes per cent. In half creamed milk it may only amount to 5 to 6 volumes. Fats in good milk ought not to be less than 3 per cent.; in creamed milk, not less than 1 per cent.

While creamed milk is an adulteration, it should be understood that skimmed milk is highly nutritious, containing all the proteids and salt of the original milk, and lacking only the fat. Therefore, milk should not be destroyed on this account.

Chemicals used for preserving milk are detected, alkalies in general, by cooking the milk one to two hours, when it will turn dark yellow or brown. Salicylic acid

is easily detected by a drop of tincture of iron, which gives a violet color.

The Degree of Freshness of milk, or its nearness to decomposition, may be approximately judged by its reaction to litmus paper (if there is any surety that chemicals have not been used to prevent souring); and second, by estimating the number of bacteria present. This is done by introducing one-half and one cubic centimetre of milk, respectively, into sterilized gelatine plates and counting the colonies which develop.

Milk in the udder of a healthy animal is germ free. In the process of milking or handling contamination is liable to occur. If very large numbers of germs are present the milk has either been exposed to excessive contamination or has been placed under such conditions as to favor fermentation.

To Prevent the Spread of Disease through Milk both public and private co-operation is needed.

(1). The *State* should take control of this product here in America as it does in many places in Europe. Competent veterinary surgeons should inspect all herds which supply the market, any found sick should be isolated, the tuberculin test should be applied to the entire herd, and the dairy regulated accordingly.

The sale of milk from tuberculous cows, and its products (butter, cheese, etc.) should be forbidden under penalty. The animals themselves should be killed. The question of indemnity to each owner for all cattle so destroyed by order of the State is one that

has been settled affirmatively in New York State and elsewhere, but it is attended with many difficulties. The rapid increase in the number of such diseased cows, many of which are very valuable, means an enormous debt to the State.

All dairymen should be obliged to conform to certain standard regulations regarding the space, light, ventilation and proper feeding of their cows, and also in regard to the cleanliness (especially as regards hands) of their milkmen.

If, in addition to this, the stall, the can, the udder, the milk-pails and pans or other vessels receiving the milk are kept scrupulously clean, much disease would be stamped out. All milk-pans should be washed in hot water with soap or soda immediately after use. In public dairies abroad these are steamed. Milkmen should be obliged to wash their hands before milking. One or two dairies are conducted on these principles with competent expert inspection in the neighborhood of New York City, but they are private enterprises. One is at Caldwell, New Jersey. Rules regarding the vending of stale or sour milk should be enforced by local Boards of Health.

(2). *Household Measures.* Two methods have been proposed to prevent the spread of disease through milk with special reference to its use among infants. These are (1) Sterilization, and (2) Pasteurization. Sterilization of milk may be effected by raising it to a temperature of 100° C. (212° F.) and maintaining it there

for 30 to 40 minutes. The milk is then cooled. In this way pathogenic and many other germs are destroyed. Milk so sterilized may be kept for days, even weeks, if properly sealed, without further alteration in its character. The objections to sterilization are that this high temperature changes the character of the milk somewhat, and affects its nutritive value; the milk sugar is diminished, and the casein so changed that it is with difficulty digested in the stomach. The taste is also somewhat affected for the worse, although many infants do not seem to object to this.

(2). Pasteurization is sterilization at a low temperature, from 68° C. to 70° C. Dr. Freeman has described the process and also has invented an apparatus for the purpose by which the milk is maintained at a temperature of about 68° C. for thirty minutes, and then cooled to a temperature of 20° C. This method is more useful than sterilization, as it kills the more infectious germs present and does not affect the constitution or taste of the milk.

Pasteurization destroys the germs of cholera, typhoid fever, diphtheria, tuberculosis and certain other bacteria which may cause digestive disturbances. It does not render all fluids absolutely sterile or kill all spores, but is sufficiently effective to check fermentation. Pasteurized milk cannot be kept more than twenty-four hours, and must therefore be prepared every day.

Dr. Freeman's apparatus consists of two parts; a

pail for water, and a receptacle for the bottles of milk. The pail is a simple tin pail with a cover. Within it there is a groove to indicate the level to which it is to be filled with water, and supports inside for the receptacle for the bottles of milk to rest upon. The receptacle for the bottles of milk consists of a series of hollowed zinc cylinders fastened together. (Fig. 9.)

The apparatus is used in the following way: The pail is filled with water to the level of the groove, covered, and put on the stove to boil. The bottles are filled with milk, stoppered with cotton and put into the cylinders. Enough water is now poured into the cylinder to surround the body of the bottle. This is necessary for the conduction of heat. When the water in the pail boils, the pail is taken from the stove, set upon a table, the lid removed and the bottles set inside. The lid is then put on, and the whole allowed to stand half an hour, after which the bottles of milk are cooled by being set in a pail of cold water, ice and water, or by running water from the faucet into the pail by means of a rubber tube attached to the faucet, which delivers the water directly into the pail.

FIG. 9.—FREEMAN'S APPARATUS FOR PASTEURIZING MILK.

In all households where there are children who

drink it, milk should invariably be boiled or pasteurized before using.

The Products of Milk. Cheese and butter are important articles of food. Butter constitutes the readiest means of obtaining fat in the dietary of the well-to-do, but is expensive. It is also liable, if made from diseased milk, to contain the germs of disease.

Oleomargarine is a fat made from beef fat, sometimes mixed with coloring matter or flavors, which on purification offers a substitute for butter. The price of oleomargarine is much lower than that of butter, and there is no reason why it should not be used, provided it is not sold as butter. It is not so assimilable as butter.

Cheese is highly nutritious, containing proteids and fat in concentrated form. This very concentration is to many a source of indigestion, and lessens its nutritive value accordingly. Laborers, however, both in this country and particularly in Europe, use it as a daily article of food in considerable quantity. It would appear that eaten with bread, as they take it, by which it is subdivided, it is more digestible. In many cases it is freshly made every day, as is the case in Switzerland. Cheese when mouldy contains the products of decomposition by bacteria, and these, as well as souring of the cheese, may give rise to diarrhœa; the ptomaine tyrotoxicon may also be evolved, producing its characteristic symptoms.

Eggs. Ordinary hens' eggs weigh about 2 oz.

They contain about 12 per cent. of proteids and the same proportion of fats, and are highly nutritious, most of the proteids being absorbed. They do not, however, contain nutrition in so concentrated a form as was formerly believed: the old formula that one egg is equal to one-half pound of meat, being a fallacy. In incipient decomposition of eggs ptomaines have been found. Good eggs sink in a 10 per cent. solution of salt, bad ones float.

Vegetable Foods. These are highly important as being: 1. The sources of supply of the carbohydrates in the system, animal food offering almost nothing in this respect. 2. They supply a large amount of the various salts needed for the body, as phosphates, calcium, magnesium, potash and iron. Sodium and the chlorides are deficient, however. 3. They are antiscorbutic. Vegetables are also in many instances sources of proteids, as seen in the leguminosæ, but vegetable proteids are less digestible than animal proteids, from their admixture with the cellulose found in the seeds. Fats are present in many vegetables, but these also are less digestible than animal fats.

The principal carbohydrates in vegetables are starches and sugars. In most fruit the principal carbohydrate is glucose. The various starches are known as arrowroot, tapioca, from the pith of the cassava; sago, from the sago-palm; potato, and maize starch. The principal sugars are cane and beet. Fruits are

rich in water, vegetable acids and salts, and are eminently anti-scorbutic.

Cereals. These are wheat, barley, oats, rice, rye, maize and millet.

In India, rice and millet are most used; in Scotland, oats; in certain Spanish American countries, maize takes the place of flour.

Wheat is the most important cereal, as being universally used as a source of bread. The wheat grain has four coats; within the innermost, which is very thin, is the grain proper in which is the starch, fat, proteids and salts. In milling, the coats are removed, as far as possible, and called bran; in whole meal the whole grain is milled.

PERCENTAGES OF WHEAT AND FLOUR.

	WATER.	PROTEIDS.	FAT.	CARBOHY.	CELLULOSE.
Grain	13.37	12.04	1.85	68.65	2.31
Flour, fine	13.37	10.21	.94	74.71	.29
" coarse	12.81	12.06	1.36	71.83	.98
" whole meal	13.00	11.70	1.70	69.90	1.90

It will be seen that the refining of wheat subtracts much of the nutriment from the flour, especially in the line of proteids and fats. Its only advantage is the withdrawal of the cellulose which is indigestible, but also somewhat useful as an intestinal stimulant, and in the improved color. It is claimed that cellulose interferes with the digestion of other foods. In fine

flour the proportion of carbohydrates to nitrogenous stuffs is as 1:7.4. To make it nearer a perfect food, therefore, flour should be eaten in less refined grades.

Gluten is the proteid of flour, not originally present in it, but formed from two antecedent proteids on the addition of water. By weight it should be from 8 to 12 per cent. of the flour.

Bread is made by aerating the flour with leaven or yeast, by kneading it with water charged with carbonic acid, or by mixing with baking powders.

During the fermenting process carbonic acid and alcohol are developed,—the particles of flour are separated and starch is somewhat digested. The fermented is believed to be more digestible than the non-fermented bread. The disadvantages of bread as a food are the same as in fine flour, viz., too little salt and too little fat. In common practice the salt is added in the mixing, and the butter used with bread supplements the deficiency of fat.

Maccaroni is a preparation of flour, and is made from the hard wheats of France and Italy, and contains a large quantity of gluten.

Oats or oatmeal is a highly nutritious food, containing proteids in large amount, as well as fats. In this last respect it differs from wheat or barley. The proportion of nitrogenous to non-nitrogenous elements is 1:5.4, showing it to be a nearly perfect food in itself. The cellulose of the grain coverings is irritating to many.

Rye is highly nutritious, but heavy and acid. Rye is subject to disease caused by a fungus, producing ergot of rye. Ergotism generally occurs in epidemics, with symptoms referable either to the circulatory or to the nervous system.

FOOD ACCESSORIES.

Certain articles of food or drink are taken by mankind which cannot be said to be absolutely necessary, which yet to some extent influence digestion and nutrition directly or indirectly through the nervous system, for better or worse. Such articles are called food-accessories, and are in almost universal use the world over. Some of these are condiments, or articles added as flavors,—mustard, pepper, onions, cloves, cinnamon, etc. Many of these, as mustard, contain an aromatic oil which stimulates digestion and peristalsis, and are also antiseptic in their action. In large quantities, however, these articles are liable to induce gastric irritation. Other food accessories are taken as drinks, as tea, coffee, cocoa, or as alcoholic drinks.

Coffee leaves are taken in infusion by two million of the world's inhabitants. Paraguay tea, by ten million; cocoa by the same number. Chinese tea, by 500 million. It is said that all nations are addicted to the use of tobacco.

The active principle of tea and coffee is an alkaloid

chemically identical in the two, but known respectively as thein and coffein.

Composition of Tea.

Thein, 1.35, combined with tannic acid. Nitrogenous elements, 9.44; non-nitrogenous, 19.20. Ash, 3.

The ash consists of potash, soda, magnesium, chlorine, iron, etc.

Indian tea is said to contain more tannin than others. Green tea has less thein and more tannic acid than black.

Cheap teas also have more tannin than costly teas.

Tea is a restorative and stimulant. In excess it causes gastric catarrh, also nervous disorders. Professional tea-tasters are melancholy examples of this.

Coffee is a cerebral stimulant, also a heart stimulant, and excites the muscles to continued activity. It is also diuretic, and to some extent it appears to increase persistalsis.

In excess it produces indigestion, evidently from delaying the activity of the stomach glands, it may also induce muscular tremor and insomnia. Persons can generally live on less food if they drink coffee with their meals, and it is believed in some way to retard tissue waste. Tea is believed to act more on the skin than coffee.

Cocoa contains theo-bromine, an alkaloid similar to thein. It has a large percentage of fat, and is highly nutritious and a restorative.

Alcohol. Alcoholic beverages may be divided into

(1) beers; (2) light wines (red and white); (3) sweet wines; (4) spirits (brandy, whiskey, etc.), all of which owe their peculiar action to the alcohol they possess. *Percentage composition of alcoholic beverages:* Beers contain from 3 to 5 per cent. alcohol; light wines, from 7 to 12 per cent.; brandy, 35 per cent.; whiskey, 52; and rum, 61 per cent.

Alcohol is eliminated by the lungs, skin, bowels, kidneys, but the amount so formed does not account for it all. It is questioned whether the remainder is utilized in the body as a food. It is generally conceded that the use of alcohol retards the excretion of carbonic acid and other excretions of the body in general. With alcohol the weight of the body is generally increased. It certainly renders less food necessary. It restrains the rapid growth of young cells (hence given in certain febrile and other disorders), reduces temperature (probably by favoring heat radiation). In large doses it evidently lessens heat production, as well as increases radiation; hence does not protect against cold.

In moderate doses (which is a relative term) it stimulates the stomach and increases the flow of gastric juice, generally exciting an appetite.

It stimulates the heart. In moderation it stimulates the brain, and rouses to greater vigor. Too long maintained, this effect becomes reversed, and depression and incoördination occur. In excess it delays digestion, causes catarrh of stomach and congestion of liver, ending in fatty degeneration and cirrhosis.

Serious affections of stomach, liver and kidneys are common with alcoholic drinkers.

The expectation of life is less with alcohol-users than with abstainers.

Experiments would show that a quantity from 1 to 2 oz. is all that can be utilized in the body; over that, the effects are those of beginning narcosis.

One oz. alcohol equals 2 oz. brandy, 5 oz. of stronger wines, or 10 oz. of weaker, or 20 oz. of beer.

Alcohol is used in the various forms of spirits, wines and fermented liquors. The commonly used spirits are brandy, whiskey, rum and gin, all of which are obtained by distillation.

Brandy is distilled from fermented grape juice. Whiskey, in this country, is principally distilled from rye, barley and corn. Rum is distilled from molasses and gin.

All of these spirits contain from 40 to 50 per cent. of alcohol, and are very irritating to the gastric mucous membrane if taken undiluted.

Wine is usually from grapes, although it may be obtained from other fruits. The stronger wines (sherry, port, Madeira) contain from 16 to 23 per cent. of alcohol. Lighter wines (Burgundy, champagnes, etc.) contain from 6 to 15 per cent. of alcohol.

The wines of domestic manufacture are less liable to adulteration than many of the foreign brands.

Beer is the fermented extract of barley mixed with a decoction of hops and boiled. It generally contains from 3 to 4 per cent. of alcohol, 5 to 6 per cent. of hops, lactic and acetic acids, and one-fourth to one-fifth per cent. carbonic acid. Adulterations are common, caramel and glycerin, grape sugar, molasses and other articles being frequently added to give richness of coloring, flavor, etc.

ANOMALIES AND ADULTERATIONS OF FOOD.

Many of these are harmless from a sanitary standpoint, although from an economic one they are important. Some are merely fraudulent adulterations and some are poisonous. For instance, the adulteration, of coffee with chicory, or butter with margarine, is a fraudulent lessening of values, but is not poisonous and does not induce disease.

Tea is adulterated with tea dust, such as the sweepings from tea-houses, and gum may also be added to it. The leaves are generally colored with powdered catechu, Prussian blue, indigo, turmeric, etc. The process is known as *facing*, but these substances are present in minute quantities only. In old tea, acari, fungi and bacteria may be found, but these are probably killed during the process of infusion.

The *coffee berry* is also faced. The extensive adulteration of coffee in America seems to be by an artificial bean, made in imitation of the coffee berry, from

earth, and corn or wheat-flour. It is heavier than the coffee bean, shows a different surface on fracture, and dissolves in water; while chicory sinks in water, and the coffee berry floats.

One sample of coffee recently examined in the Paris Municipal Laboratory was reported to contain red earth, flour, coffee grounds, caramel, talc, plumbago, vermicelli, semolina powder, bean dust, carrots, bread-crusts, acorns, sawdust, red ochre, brick dust, ashes, mahogany shavings, vegetables, earth and sand-fox.

Canned food is liable to intentional adulteration from copper, which is added to pickles to give them a bright color, also to some varieties of peas. *Accidental adulteration* may occur; for instance, lead from the soldering sometimes is found in canned vegetables. The quality of the tin used influences the condition of these products also; as in poor tin the salts may be dissolved by the juices of the vegetables. Sulphide of tin may be formed by the action of the albuminous matter of vegetables. This has been found in cans of asparagus, etc. Time appears to be a factor in this, the freshly canned articles being less liable to such conditions. The remedy proposed is to coat the interior of tin cans with a varnish capable of resisting weak acids. Cases of poisoning have been known from such action occurring with zinc covers of glass jars. In *canned fish* ptomaines are sometimes developed which give rise to cramps and other intestinal disturb-

ances. Properly canned fruits and vegetables are a most desirable addition to our food resources, as they are sterilized in the process, and offer some of our safest resources in winter.

CHAPTER VIII.

THE DWELLING.

A large amount of preventable illness can be directly traced to unsanitary conditions of the dwelling, due either to its bad construction in the first instance, or to careless management of its appointments afterward.

Foul air, dampness, and lack of sunlight in the dwelling are generally due to the lack of sanitary science in its construction, and all of these tend to encourage conditions which favor, if they do not originate disease.

The hygiene of habitation includes the considerations of site, architectural details, ventilation, heating, the disposal of garbage and excreta, and may properly concern itself with the enforcement of certain details of the housekeeping, especially concerning its cleaning and furnishing.

The Site. The city householder has less opportunity for selecting his site than the country dweller. Proper conditions of the soil, however, as related to building-sites, should be regulated by local Boards of Health, and are so in many cities.

The soil should be dry, the sub-soil sufficiently

permeable to permit good natural drainage. (See Chapter on Soil).

If obliged to use an impermeable soil, this should be thoroughly drained, as careful under-draining will make even bad soil habitable.

What are known as *made soils* are regions used for dumping garbage, ashes, etc., for the purpose of filling up uneven ground. Such places are not suitable for building-sites, at all events not until the material has been oxygenated by long exposure to the atmosphere.

Experiments made on such soil in England showed that the destructible matter is not so oxygenated under three years time. Where wood and woolen cloth were included in the garbage, more time than this was required for the oxygenation of these materials.

The soil under a dwelling should be covered with concrete to prevent moisture rising from the ground.

The walls of a house are best made of some fairly porous material, especially in temperate climates, as air in such materials acts as a non-conductor, and therefore preserves a more even temperature in the dwelling.

Yellow brick is one of the most permeable materials to air, red brick coming next.

Stone, particularly granite, is very non-absorbent, and this, with its known durability, makes it an excellent material for buildings.

Wood is a little better non-conductor than brick, but is only permissible in country regions on account

of its inflammability. Its liability to decay and to harbor vermin lessens its value.

House walls should be made double, the intervening air space serving to maintain a more even temperature as well as to insure greater quiet.

Every precaution should be taken to protect the house from dampness, and this is best effected by the introduction of some non-absorbent material into the walls, both at the foundation and also at the ground level, which will act as a barrier to the ascent of moisture by capillary attraction from the soil.

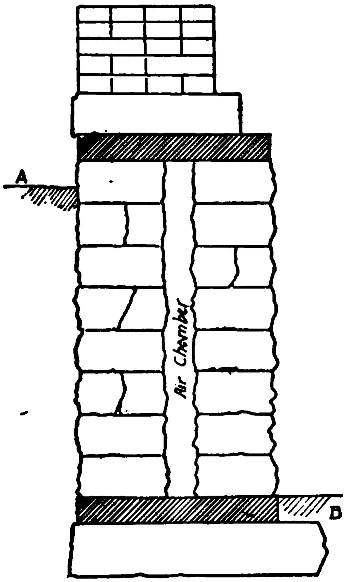


FIG. 10.—DAMP-PROOF COURSE, INDICATED BY DARK STRATUM OF SLATE RUNNING BENEATH CELLAR, AND ABOVE GROUND LEVEL. *A* Ground Level. *B* Cellar Bottom.

Moisture has been known to ascend in this way as high as thirty feet in unprotected brick walls.

This barrier is technically known as a *damp-proof course*, and may be made of slate, asphalt or cement. Fig. 10 shows such a damp-proof course for the foundation of a dwelling. The air-chamber requires ventilation.

Roofs may be made of various non-absorbent, durable materials, such as tin, slate, tiles, etc. Cement is extensively used in Germany, and offers the great advantage, in addition to its durability, that with it a garden roof is possible without detriment to the rooms below. Roof-gardens would be found such a luxury in temperate and warm climates, especially within the confines of cities where garden and out-of-door space is limited, that the introduction of cement to further this end is to be desired.

Glass building blocks have been recently invented in Switzerland; it is claimed they may be of great practical use to architects in providing means for the lighting of dark corners, or remodeling of old buildings.

They are made in flask shape, about eight inches long, and two and a half inches deep, and so modeled that they are laid top and bottom with ordinary cement, the sides being fastened with rubber cement, and are said to be practicable both for inner and outer walls for a limited height.

The light transmitted is almost equal to that of ordinary glass, and there is the further advantage that the block does not admit of anything being seen from the opposite side.

The Cellar of the house should have a flooring of cement, and the side walls for a few feet may advantageously be covered with the same material. Windows should be numerous enough to provide light and air.

Floors should have some interlining or filling to insure warmth and quiet. Hollow terra-cotta bricks, which are fire-proof, are used for this purpose, and also sand in some cases. If sand is used, it should be taken from a clean region, and preferably should be made sterile before using.

Floors should be laid smoothly to facilitate cleanliness as well as beauty, and should be so finished as to make them impermeable to dirt and moisture. Oak and other hard wood is always preferable when possible, but excellent floors are made of yellow pine, carefully joined, any intervening crevices being filled in with wood cement or putty, and afterward treated as described below.

Where the floor joins the wall at the baseboard a concave moulding should be used to promote cleanliness, the customary space in that region being a great receptacle for dirt, bacteria in great numbers being found in such regions.

To make such a floor non-absorbent it may be treated with three coats of boiled linseed-oil and then waxed or treated with shellac. This will render it impermeable to dirt and moisture, and suitable for rug coverings instead of carpets.

A less expensive method is that of using coal-tar with one-quarter of its weight of coal-oil. Three coats of this applied at intervals two days apart may be used. The floor should first be thoroughly cleaned with soda and hot water. The tar may be applied cool.

Where floors are old they can be well painted in a color to harmonize with the room decoration, or stained and varnished, and will look well when covered with rugs, and, if all cracks are well puttied up, can be kept clean.

Carpets which cover the entire floor should not be used. Rugs, which can be beaten and brushed out-of-doors, should be substituted, by which the dissipation of dirt and bacteria can be insured without the house. Rugs are now made of such a variety of materials as to be within reach of all.

The usual dust-raising commotion of a general sweeping, especially where tea leaves, sawdust or damp paper are not used to "lay" the dust, can never be effectual in ridding a house of its weekly accumulations of dirt. More dirt can always be beaten out of a carpet after these cleanings, and much of the dust that arises is not and cannot be wiped away, as it settles on walls or remote and high places of the rooms. Feather dusters should never be used, as they only serve to displace the dust from surfaces in view to others less visible, and therefore do not remove the dust from the room. Places within reach should be wiped off with a slightly dampened dust-cloth. Those beyond reach, with a long-handled broom about which a canton-flannel dust-cloth or bag has been tied. As these cloths can be readily washed, the dirt from the house is by this means really removed. Hard wood floors can be dusted in the same manner with great ease.

These details are essential if we would keep the dwelling free from the germs of infectious diseases, which are always liable to be brought into it on clothing, or on the dirt of shoes. It is a well-proved fact that tuberculosis, which is mainly acquired through the pulverized sputa of tubercular patients which is disseminated by dust, is seldom, if ever, acquired from the dust of the streets, to which a person is rarely exposed for any continuous period, but that the dusty air of dwelling-houses is the great source of such infection.

The exacting cleanliness of the old-fashioned housewife has therefore in these days a scientific basis, since we have learned that dust is such a common carrier of disease.

Sleeping-rooms should be light and, as far as possible, on the sunny side of the house. At least six hundred feet of air space should be allowed for each person, and an allowance of one thousand is much better. Provision should be made for the admission of pure air and the exit of foul air. Windows should be opposite one another so that cross ventilation will be possible. A fireplace opposite a window will answer the purpose of ventilation, but this arrangement is apt to carry off the heat too readily. These points will be further discussed under the head of Ventilation.

The walls of bedrooms should preferably be painted in oil, so that they can be wiped off when necessary with a damp cloth. Wall paper, if used, should be

smooth. Rough surfaces, such as are found in cartridge papers, catch and hold dust-particles and are not easily cleaned. Arsenic is very much used in wall-papers, both in white, green, and sometimes in other colors, and cases of arsenic poisoning have been attributed to this source. The evidence, according to Chandler, however, is not at all conclusive, as arsenic is not volatilized under those conditions, and it is difficult to see how it could otherwise affect the individual.

The floors of bedrooms may be treated as already described, if not originally laid of hard wood, and should then be covered with rugs, in place of nailed-down carpets. Any draperies used should be light and of washable fabrics, and so hung as to be easily removed for cleaning. With due regard to comfort any excess of furniture in bedrooms should be avoided. Heavily upholstered furniture should be replaced by such as is easily moved, with adjustable cushions, if any are required, covered with cotton fabric. In general, every detail should be planned with an eye to facilitate the scrupulous cleanliness of the room.

Discretion should be used in the apportioning of the rooms to various uses. Inasmuch as all the rooms of a house are seldom equally exposed to sunlight, those that are less constantly in use should be upon the north side, such as the dining-room, the guest-chamber, billiard-room, etc. The sunny rooms should be reserved for living rooms, particularly for the nurseries

or other apartments for children. The bath-room and the water-closets should always communicate directly with the open air by means of a window. The special arrangement of these rooms is treated under the section of Plumbing.

In general, the decoration of the house should be dominated by the desire to have healthfulness and beauty united, and with a little intelligent study and the application of good general principles these will be found perfectly compatible. Smooth surfaces both in draperies and furniture coverings will be found to retain least dust, and therefore can most readily be kept clean. Such fabrics are obtainable in the market, in artistic colors.

The kitchen floor and closets should be rendered impervious to dirt, either by the treatment suggested or by covering with oil-cloth, which facilitates cleansing. The walls should invariably be oil-painted for the same reason. Cement floors have been recommended, but are rather cold. When practicable, the laundry should be in a separate apartment. Soapstone tubs, or porcelain, are very desirable, and the laundry floor should be cemented, if possible.

The lighting of the house is preferably done by electricity, where this is possible, as gas not only consumes the air but also yields carbon dioxide and other gases to the atmosphere during combustion, as well as heat.

In any large drawing-room where many persons

assemble, some provision should be made for carrying off these products of combustion from gas chandeliers into the outside air by a separate flue going either into the chimney or directly out-of-doors.

Trees should never be planted in the immediate vicinity of a house. They absorb and evaporate so much moisture as to make a constantly damp climate about the house, and at the same time shade the walls and the soil from the beneficent effects of the sun.

CHAPTER IX.

Ventilation and Heating.

The process of ventilation has been well described as the circulation of air through a channel which must have two ends, each end being in the open air.

REQUIREMENTS FOR VENTILATION.

Ventilation is required to rid the air of its gaseous impurities and watery vapor which result from the respiration and transpiration of human beings, and to reduce these to such an extent that the air of inhabited rooms shall not be detrimental to health. Solids, as dust, micro-organisms, etc., are not removed by the ordinary means used for ventilation, and the circulation of fresh air through an apartment cannot therefore take the place of methods of cleaning.

It is manifestly impossible to maintain the air of dwelling-houses in as pure a condition as that of the external air, and therefore sanitarians have been obliged to agree upon a standard of *permissible impurity* of the atmosphere consistent with perfect health.

It has already been shown that carbonic acid gas is a reliable index of respiratory impurity, and the

question then arises, what amount of carbonic acid shall be accepted as the limit of permissible impurity?

Experiments have shown that when carbonic acid is in excess of .6 per 1,000 volumes of air the organic matters present become offensive to the senses, and that persons habitually exposed to the atmosphere containing carbonic acid much in excess of this quantity suffer in health. Air with a ratio of .8 or .9 or 1 per 1,000 volumes becomes "stuffy," close and foul.

The normal ratio of carbonic acid in the atmosphere, as already said (*vide* Air), is .3 per 1,000 volumes. The addition of .3 per 1,000 volumes to this from the respiration of human beings is known as the "permissible respiratory impurity," for the reason already given, viz., that when a larger amount than this is present in the atmosphere other impurities are found to have increased with it which render the air offensive and harmful. .3 carbonic acid per 1,000 volumes (normal amount present) + .3 per 1,000 volumes (permissible respiratory impurity) = .6 per 1,000 volumes, which is the limit accepted for pure air.

The average person exhales .6 cubic foot carbonic acid per hour. Various experiments have established the fact that 3,000 cubic feet of fresh air per capita are needed to dilute this amount of carbonic acid to the above required standard.

It will be noticed that .6 cubic foot carbonic acid is the amount exhaled by the *average* community. As the amount actually differs according to age, sex,

work or rest, the fresh air required must be proportionately increased. The following from Parkes gives comparative differences:

AMOUNT CO^2 EXHALED PER HOUR.

Children,	.40 cubic foot.
Females,	.60 "
Males,	.70 "
" light work,	.95 "
" hard work,	1.96 "
Average community,	.60 "

AMOUNT FRESH AIR REQUIRED PER HEAD PER HOUR.

Children,	2,000 cubic feet per hour.
Females,	3,000 " "
Males,	3,500 " "
Mixed community,	3,000 " "

As more CO^2 and other impurities are exhaled during work than when at rest, the amount of air supplied should be proportionately increased in factories and workshops.

Light work,	4.750 cubic feet air per hour.
Hard work,	9.800 " "
In mines,	6.000 " "
Animals,	10-20.000 " "

depending on their weight and life in open air (20 to 25 cubic feet per hour per pound of body weight).

The sick in hospitals require at least one-fourth more than the average person, viz.: 4,000 cubic feet per capita, and in serious cases, surgical or septic, the amount should be practically unlimited.

The quantity of watery vapor thrown off by the skin and lungs varies with the individual and the state

of the atmosphere. It is estimated from 25 to 40 oz. in 24 hours, and requires about 210 cubic feet air per hour to sustain it in the form of vapor.

The products of gas or other illumination must also be considered in providing for ventilation. Every cubic foot of gas requires 1,800 cubic feet of air for proper ventilation. As a small gas burner will burn nearly 3 feet per hour, and 10 to 12 feet during an evening (4 hours) from 18,000 to 21,600 cubic feet of air must be introduced for this purpose. Gas gives off a large amount of heat and watery vapor, as well as gaseous products other than carbonic acid, all of which are hurtful. Their dilution and removal should always be provided for by the architect in ventilating a building, and failing this, additional means for ventilation should be added afterwards.

Cubic Space Required. The amount of air required per head per hour determines to a large extent the size of a room. If a room only contains 100 cubic feet air space, the air would have to be changed 30 times per hour in order to introduce the required 3,000 feet in that time. This would manifestly be very uncomfortable to the person, owing to the draughts produced. The ventilation of small spaces is difficult, because the position of the inlets is necessarily near the person, producing disagreeable draughts. This is well illustrated in the case of prisons. In hard-labor prisons, where the convicts are confined in their cells only during the hours of rest, the cell-space seldom exceeds 200

cubic feet per head. In cold weather the draughts become so unpleasant that prisoners block up the inlets as far as possible, with the result that ventilation is obstructed to a serious degree. (Wilson).

With a cubic air-space of 1,000 feet per head the air, at ordinary temperature, can be changed three times per hour without creating any sensation of draught. Parkes considers this the minimum air-space. Practically this is seldom attained. Six hundred cubic feet is considered a fairly generous allowance. In hospitals 1,200 or 1,500 feet are required for good ventilation.

Pettenkofer has shown that a very small space can be ventilated without draughts, if artificial appliances are provided in perfection, but these appliances rarely exist, and we must aim at an ideal provision of space and air. In the dwellings of the poorer classes the air-space seldom exceeds 200 cubic feet per person, but it is well known that the disastrous effects of such overcrowding are only too manifest in the increased rate of mortality. This small air-space is also found in some of the public schools of New York.

Too small a space also prevents good diffusion of the air, as inlet and outlet are often very close together, generally directly opposite one another, with the result that the air passes through and out of the room in a direct current without being well diffused.

These observations have been certified to by scientific experiments, showing how purity of the atmosphere varies largely with the initial cubic space allowed.

AVERAGE ANALYSIS OF AIR OF SLEEPING ROOMS, 12:30 TO 4:30 A.M.

By Carnelly, Haldane and Anderson.

Cubic feet per Head.	*Temperature.*	CO^2 *per 1000.*	*Microbes per cubic foot.*
100-180	55°	1.15	80
180-260	54°	1.07	49
260-340	53°	1.03	32
340-500	57°	.92	42
500–1,000	54°	.86	6
1,000–2,500	53°	.67	9

Sufficient *floor-space* should be allowed. A very high ceiling (over 12 to 14 ft.) does not compensate for very limited floor-space, as it has been found that organic impurities are not equally diffused in that case, but tend to remain in the lower strata of air. The floor-space should not be less than one-twelfth of the cubic space. In London lodging-houses 30 square feet per head is an ordinary allowance, and in the Board Schools it may not exceed 8 square feet.

Animals should have even more space than the above allowance.

NATURAL AND ARTIFICIAL VENTILATION.

I. Natural ventilation goes on by reason of three forces always at work, viz.: (1) Diffusion of gases. (2) Inequalities of temperature; and (3) Winds. The first, *diffusion*, is inadequate as a constant force, for while it operates by producing a fairly even distribution

of the products of respiration and combustion, it only aids, to a slight extent, in removing them from the room, and is altogether ineffectual as regards the removal of organic impurities. Therefore, although it may be an aid to ventilation, it cannot be relied upon under the ordinary conditions of living. Paper and paint interfere with diffusion, as also does dampness of the walls.

2. *Movements produced by inequalities of temperature.* This is one of the chief means of ordinary ventilation of houses. It is well known that warm air being expanded by heat is lighter than cold air, and hence a constant interchange and movement of air-currents goes on whenever there is any difference between the internal and external temperature. Pettenkofer found that the air in a room was changed once in an hour when there was a difference of 34.2° F. between the internal and external atmosphere, the room having brick walls.

3. *The action of winds* and slighter currents is due to inequalities of temperature between masses of air. These currents greatly assist ventilation by their perflating and aspirating force. Perflation is best exemplified by the cross-ventilation which takes place when opposite windows are opened. This is an excellent method of ventilation and one that should be practiced in every household, and especially in hospitals, so far as possible; but it is uncertain, because the rate of aerial movement is irregular. If very rapid,

a violent draught results and becomes unbearable, while if the air is stagnant the impurities are not carried off by the current.

The aspirating force of the wind produces up-currents through chimneys and shafts by creating a constant vacuum which constantly sucks up air from the room. In natural ventilation, as carried on in habitations, windows generally act as inlets for fresh air, and chimneys as the outlets for foul air. In cold weather, when windows are generally closed, the chinks and crevices around and under doors and windows furnish the inlets; but when a house is tightly built, even these are closed. The house ventilation then consists of the short morning airing when bedrooms are being put in order, and of the chance opening of outside doors when the cold air rushes in in large volumes. These opportunities are manifestly inadequate to keep the air of dwellings pure.

Numerous appliances have been devised which may either be built into the house or attached to windows, which shall furnish a permanent inlet for fresh air without draughts. Some of these devices are as follows:

1. Doubling some of the panes of the window. One or more of the outer panes of a window may be doubled and have an open space at the bottom, while an inner pane may have a corresponding open space at the top. The cold air in entering is thus diverted upward between the panes and falls gradually to the floor by virtue of its greater density.

2. Raising the lower sash of the window two or three inches and filling in the open space with a piece of wood (Bird's method). This leaves a corresponding space between the meeting rails in the middle of the window through which the entering current is directed toward the ceiling, thence being diffused through the room.

3. Having the window so constructed that the top slopes inward when opened, so that the current is first directed upward, and does not directly strike the person. In schools or churches when windows are large only a portion should open in this way.

4. Other inlets may be provided by inserting perforated bricks in the walls near the ceiling. The Sherringham valve is of this description. Perforated bricks or grating are introduced into the house-walls, through which the air enters, and a valve attached inside which closes at will by a balanced weight. It slopes inward, and upward when open, so that the entering current is directed toward the ceiling.

Ellison's conical bricks, to be inserted in walls, are pierced with holes, large externally and numerous and small internally, so that the air enters in finely divided currents, without creating a draught.

5. Tobin's tubes are vertical tubes opening below to the external air and carried for some distance up the walls of a room so as to obviate the discomfort of draughts. These may be used to improve the ventilation in schools or other rooms where the windows are

only on one side and perflation is therefore impossible.

Fig. 11 shows three of these appliances as they might be arranged in the house; of course they would not all be needed in one room.

Hollow metal cornices are made for ventilating large rooms, which run continuously around the room.

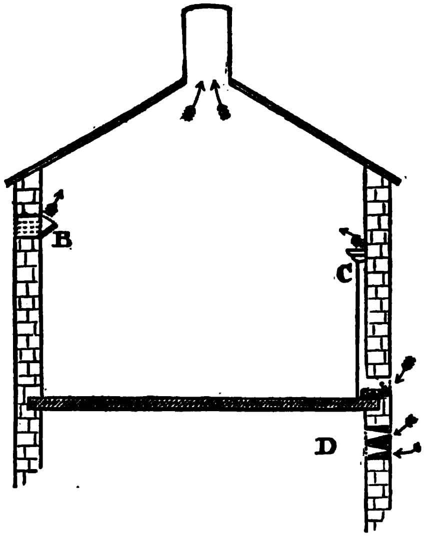


FIG. 11.—APPLIANCES FOR VENTILATION. *B*, Sheringham Valve; *C*, Tobin's Tube; *D*, Ellison's Bricks.

The cornice is divided longitudinally by a partition into two channels. The fresh air is admitted through openings in the wall into the lower channel and falls imperceptibly into the room through numerous perforations. The upper channel communicates either

with the smoke-flue or other air shaft and receives the vitiated air through similar perforations.

As the fresh air is colder, it descends by its own gravity, and the vitiated air of the room being warmer rises to the highest point; the principle is a good one, and English authors recommend it for buildings which have been erected without proper provision for ventilation, as being sightly, economical and efficient. All such appliances, it should be remembered, will collect dust, often in large quantities, from the air passing through them, and will require cleaning. As far as possible air filters should be used. The simplest is made by covering the inlets with cheese-cloth or cotton wool. Tobin's tubes are sometimes provided with a small chamber at the bottom, and the motion of the air through them being comparativaly slow, the dust falls to the bottom of these chambers and can be removed.

The perflating and aspirating power of the wind is taken advantage of for the ventilation of ships through cowls and air shafts, by which one is made to face, the other to turn away from the wind, so that a system of inlet and outlet is in this way provided.

Ventilation of railway cars is notably inefficient, the arrangement of the ventilators being such that when they are open the wind blows down upon the passengers. It is highly desirable that some system of adequate artificial ventilation be provided for these conveyances by which pure air can be constantly supplied.

The appliances considered are useful as inlets for fresh air. They may also become outlets for vitiated air under some circumstances. The outlet generally present, however, is a chimney, which may be made available in every room. A chimney in the summer time may serve as a good outlet even when it is not heated, but heat greatly increases its ventilating power. A gas-jet may be used in the summer time, or a small oil-lamp, which will sufficiently rarefy the air to produce a constant upward current. One cubic foot of gas will send out 1,000 feet of air.

During about nine months of the year, however, the problem of heating has to be considered with that of ventilation, particularly in connection with artificial or mechanical methods of ventilating.

Ventilation by itself is a comparatively easy problem, as would also heating be simple if considered alone. The combination of the two is difficult, because the methods used for introducing fresh air and removing the vitiated air of an apartment also carry off considerable heat at the same time.

The ordinary methods of heating are fireplaces, stoves, furnaces, steam and hot-water apparatus.

Heat used for warming is propagated by radiation, conduction and convection, sometimes by a combination of all three. Incandescent fires heat by radiation, and somewhat by conduction as well through the iron fittings of the grate, etc. Stoves heat principally by conduction, and, if highly polished, somewhat by radia-

tion, while steam and hot-water heating is effected by convection entirely.

IDEAL REQUIREMENTS FOR HEATING APPARATUS.

In heating, the quality of the air supplied must be considered, *i.e.* its moisture or dryness, as well as the quantity supplied by the apparatus in question. A large quantity of moderately-heated air is much more healthful than a smaller quantity of superheated air. The proper temperature of a room depends somewhat upon individual circumstances, (age, sickness, activity, etc.), but in general a temperature of 68° to 70° is found most agreeable in this country. The capacity of air for moisture depends upon its temperature, the hotter it is the more moisture it can hold. Overheated air lacks moisture, and will substract it from any surface in the room—the skin, hair and mucous membranes of a person, from furniture or other sources, hence the discomfort experienced in overheated rooms.

Thorough combustion of fuels, carrying off of smoke and gases, and provision for ventilation, are the requisites for heating apparatus. The faults of most heating apparatus are mainly due to their superheating the air, and to their lack of any provision for ventilation.

Grates or other Open Fireplaces. An ordinary fireplace will prove an excellent aid to ventilation if the room is at the same time provided with a good inlet for fresh air. As the hot air is continually passing up the chimney it creates a constant vacuum in the room

which must be supplied from some source. If this supply is furnished from a pure source the air of the room will be constantly purified, as a grate-fire completely changes the air of a room four or five times an hour, extracting from 10,000 to 20,000 cubic feet per hour through the chimney. If, however, pure air is not provided to meet the demand (as is the case in most of the older fireplaces), the air of the halls, the kitchen, cellar, or water-closet, is drawn upon with the result that good ventilation (*i.e.* a complete replacement of vitiated air by pure air) is not accomplished. The ordinary fireplace is also extremely wasteful of fuel, as only 12 per cent. to 14 per cent. of the heat generated is utilized in a room, the remainder escaping up the chimney with the products of combustion. The common experience in a room so heated is that the person near the fire is very hot, while at any distance from the fire the room is cold.

Improved fireplaces, or ventilating stoves, such as the Galton stove in England, the Jackson fireplace of New York, and others with similar arrangements, largely do away with the objections regarding ventilation, and, from their construction, are much more economical of heat. These stoves and fireplaces all possess some false back, behind which is an air-space communicating with the outer air by a flue in the floor, which discharges this fresh air into the room by suitable apertures or registers near the mantelpiece or cornice. The cold air in entering strikes against the warm iron

back of the stove, where it is warmed by the contact with the heated metal, and this constant supply of warm air stops the leakage referred to from cracks, or other rooms. In these grates the saving of heat is about 35 per cent., *i.e.* three times as great as in the case of a common grate.

Fig. 12 shows the arrangement of the rear of the

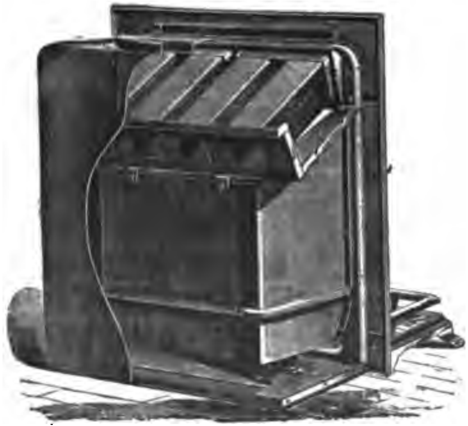


FIG. 12.—REAR VIEW OF SANITARY GRATE, WITH CASING CUT AWAY TO SHOW INTERIOR CONSTRUCTION AND AIR CHAMBER.

Jackson's Sanitary grate, the front being precisely like an ordinary handsome grate.

Fig. 13 indicates the circulation of air currents in the room with such a grate.

STOVES AND FURNACES.

Heating in the first case is direct, and by furnaces indirect. A stove heats by conduction, as well as by

radiation, and the heat might be healthful and agreeable if it was produced at a moderate temperature and if any real ventilation was maintained. Unfortunately these points are seldom possible in ordinary stove-

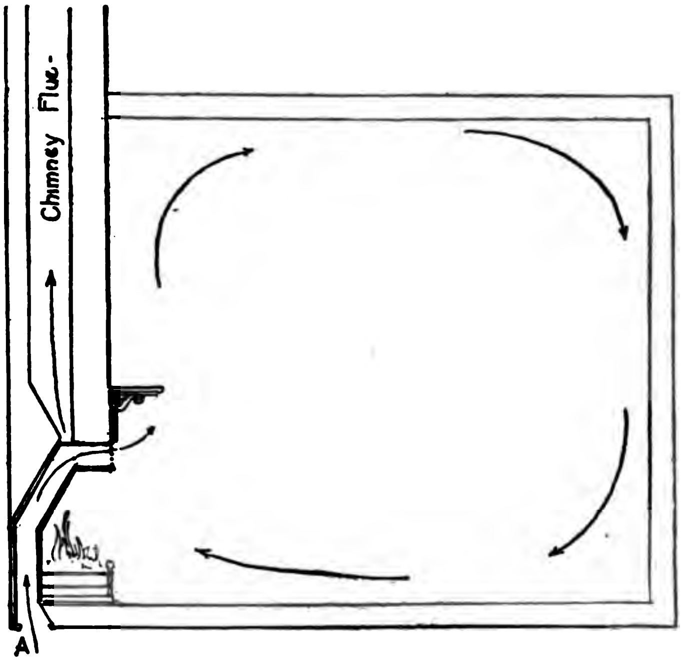


FIG. 13.—CIRCULATION OF AIR WITH SANITARY GRATE.
A, Fresh Air Inlet.

heating. Air heated by contact with a *moderately* warmed surface, as the German or Russian stove, is very agreeable. The Russian stove is a rectangular mass of brick-work, 6 to 10 feet high, which both heats and cools slowly. It is so built that the smoke and

consumed air are conducted several times up and down through the structure before reaching the chimney, thus intensifying the heat of the bricks, which in turn warm the room. A strong fire is made in the morning, and when the wood is wholly converted into live coals the stove is closed to render it almost air-tight. In this way the warmth is retained for a very long time (as long as 24 hours) without fresh firing.

The porcelain stove of Germany is essentially similar. A soap-stone furnace is made in this country, which has given great satisfaction, in which the heated smoke is caused to pass repeatedly over the internal surfaces of the stove, the fresh air becoming heated by contact with the numerous flues, and finally collected in a reservoir-box for distribution.

In France furnaces are made of hollow bricks which form channels for fresh air, and the smoke is used to warm these bricks.

The faults of the small stoves in common use are that they provide only a very limited surface for heating, so that in order to warm the room they must be run at high speed, and thus they superheat the air; they also seldom have any provision for the introduction of fresh air. The ventilating power of most stoves is very slight, as they require only one-tenth of the air necessary for an individual in an hour; hence some additional provision for changing the air must be made. These difficulties may be partly removed by having a double sheet of iron about the stove, which

forms a false back, and bringing in fresh air from out-of-doors, which may enter through a flue below the stove and be heated by passing up over the false back.

Wrought-iron stoves appear to be more desirable than cast-iron, as the gases which arise during combustion may pass through the joints of cast-iron. Contamination of the air by CO^2 is also said to be a source of danger with cast-iron, although some experiments in 1881 by Remsen seem to show that these views should be modified. (Parkes.)

The essentials for stove or furnace heat are: (1) A brick-lined fire chamber. (2) An exhaust flue for foul air. (3) A supply of fresh air.

There are several important points to be considered in furnaces in order to have them healthful. A large heating surface is necessary, so that there may be a margin for cold weather, and also that the furnace may be run at moderate speed in order not to superheat the air. Furnaces should not be run to supply heat in excess of 90°–120° F. according to the weather. This temperature refers to the heat as it first issues from a furnace; it is of course greatly cooled in its passage through the flues. A furnace should have ten square feet of surface for every pound of coal burned per hour. Overheating is likewise prevented by providing large supplies of fresh air and large channels for its escape into rooms, so that the air does not remain long enough in contact with the heated surface to become overheated.

To ensure good ventilation the furnace should always be provided with a cold-air box which draws its supply from out-of-doors, not from the cellar. This is indispensable, as the cellar air is liable to be charged with dampness, dust and, in some cases, effluvia from vegetables or other stores. The care of the cellar, in fact, is a most important point in American households, where artificial heat is necessary nine months in the year. The heat of a furnace constantly generates currents which carry the cellar-air up and about the house, distributing any undesirable elements it may possess. The cold-air box should open upon a source of pure air, and should be protected from the dust by a screen or cotton cloth.

A source of unpleasantness is the occasional escape of gas from the furnace when the door is opened, or when fresh coal is put on. This will not occur if the rule is observed never to close the damper in the chimney. The entrance of fresh air may be cut off by closing the draughts of a stove if the fire is to be kept low, but the chimney-damper should always be kept open to facilitate the escape of the products of combustion. Provision should be made for adding moisture to the heated air from the furnace. This is commonly done by providing a pan of water over which the air passes, abstracting moisture before it is distributed to the flues.

A very good combination for health and comfort is a well-arranged furnace, and, in addition, open fire-

places in the rooms. The furnace heat supplies warmed fresh air, while the chimney in each room acts as an extractor of the vitiated air. This it will do generally, even where there is no heat in it, and in that case it is very useful in reducing the furnace heat to its own level.

Heating by Hot-water and Steam. The advantages possessed by both hot-water and steam-heating apparatus lie in the power to transfer the heat to any desired point. *Hot-water* has the additional advantage of supplying heat at a very moderate temperature—the water in the pipes being below 212°, and the air heated not above 113° F. Both of these methods require provision for ventilation. The disadvantage of hot-water is the expense, and also the fact that the temperature in the pipes cannot be raised quickly. The principle is founded on the laws of gravitation. A boiler is at the bottom of the system, with hot and cold-water pipes respectively communicating with the top and bottom of the boiler, whence the water rises in one by its own expansion, and is carried over the house and, being cooled, descends again in the other by gravity. The system requires care in the setting, otherwise the principle by which it works is interfered with. Fig. 14 explains the principle of the plant for hot-water apparatus.

Steam-heat may be direct or indirect, *i.e.* the radiators may be placed in the apartments, or the heat may be generated in the basement and conducted by flues into the different rooms, entering through a register.

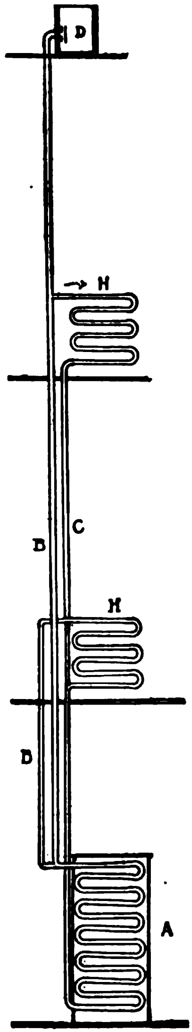


FIG. 14.—*A* is a hot water heater with ascending pipes, *B*, to radiators in various rooms, *H*. *D* is expansive tank. *C*, descending pipes, containing cold water, passing to bottom of boiler.

The advantages of steam-heat are, that it is easily managed, works quickly, and transfers heat to any distance.

The disadvantages are, that it is noisy, and too often lacks provision for ventilation, although this latter may always be remedied when the radiators are in the room (direct system). For this purpose fresh air may be brought in by a flue and, passing over the radiator, will insure a constant supply of warm, pure air. Fig. 15 shows such an arrangement.

Other Methods. Gas-stoves are allowable, and in fact are both convenient and agreeable, when provision for proper ventilation is made. The products of their combustion are principally carbonic acid and sulphurous acid gases and watery vapor. Where there is a chimney in the room the gas-stove may be set in the fire-place with the usual stove-pipe for extraction of foul gas. In a

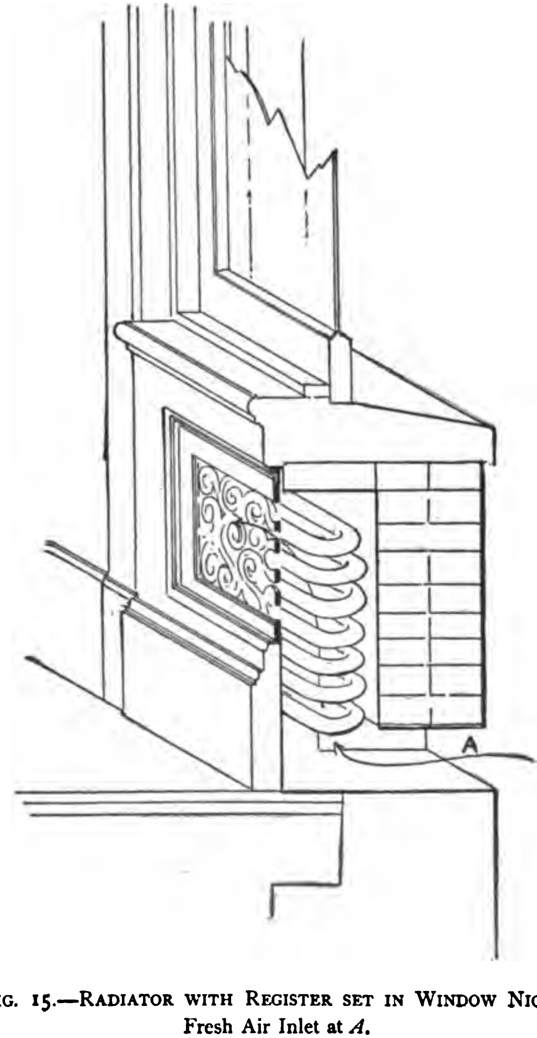


FIG. 15.—RADIATOR WITH REGISTER SET IN WINDOW NICHE.
Fresh Air Inlet at *A*.

hall bedroom not so provided, an escape-pipe may be run out through an opening made in the window, or wall if possible. Gas-stoves are made in England with a water-pan to absorb the sulphurous acid gas, but the carbonic acid still remains. In a thoroughly well ventilated room this might escape through the ordinary means for ventilation, but heating by gas cannot be considered hygienically good, unless some provision is made for the extraction of the products of combustion, as well as for an inlet for fresh air. The convenience and cheerful appearance of these stoves make it desirable that such improvements should be added to them, and the entire absence from dust, ashes and smoke which attends their use would make them a boon to housekeepers if compatible with health. They may advantageously be used for cooking-stoves, in which case there is a regular stove-pipe run into the chimney for extraction of smoke or gas, and their cleanliness and ease of handling are here very noticeable.

VENTILATION BY MECHANICAL APPLIANCES.

II. In large buildings, such as theatres, schools, hospitals, etc., which are constantly occupied by large numbers of persons, ordinary methods of ventilation are found to be inadequate. To meet these requirements mechanical means are used. Fresh air may be driven into an apartment so as to force out the air already in the room, which is the method by *propul-*

sion, or plenum system; or the air may be drawn out of a room or building, so that its place may be filled with fresh air, which is the method by *extraction* or aspiration.

Extraction. The common chimney is a familiar example of the method by extraction. A fire starts a current of air up the chimney which is proportionate to the size of both, and in this way air is drawn into the room to fill the vacuum. An ordinary grate-fire makes a current of from 3 to 6 feet per second; larger fires, 8 or 10 feet. In such a room the movement of air is constant from the inlet toward the chimney, and other currents are also started in the room.

Extraction by the sitting-room chimney is a type of what goes on in a larger scale where this method is used. In mines, a fire is lighted at the bottom of one shaft which starts a current upward, and in like manner air is drawn down another shaft which acts as an inlet, and the air is made to traverse the galleries, directed by partitions. Several French and English hospitals are ventilated in the same way. A central chimney is built with a fire at the bottom, and into this chimney, close to the fire, several flues carrying the foul air are brought from the different adjoining rooms. The Glasgow Hospital is ventilated by this method. Extraction may also be accomplished by a revolving fan or screw. A large New York school has the direct method of steam-heat for warming. Inlets for fresh air are provided below the windows, the air

passing over and being warmed by the steam radiators as it enters. Foul air ducts run from each room to the top of the building where they empty into an air chamber. A revolving wheel which can extract 30,000 cubic feet per minute is placed in this air chamber, which aspirates the foul air from these ducts. It then passes out at the roof. When the system is working well the air in the school can be changed six times an hour without creating any draught, and it is claimed that the wheel can exhaust all the air in the building in five minutes.

In theatres the aspirating power of the heat from the gas chandeliers is utilized for ventilation. A perforated cornice or an open flue is placed above the jets for the extraction of air. As one cubic foot of gas will cause the discharge of 1,000 cubic feet of air, this method would obviously be practical, were it not that the electric-light will probably soon supersede gaslight everywhere.

The principal objections to extraction seem to be that there is a great inequality of draught, as it is impossible to keep the fire in the extraction chimney at a constant height, and also there is great inequality of the movement of air from different rooms, the rooms nearest the shaft having the best ventilation.

Propulsion. The method by propulsion is effected by a revolving fan, generally enclosed in a box, which is worked by hand, steam or horse-power. The air enters through an opening in the centre of the box,

and by the revolutions of the wheel is thrown out into a conduit which through various channels conducts it to the different rooms. This is known as Van Hecke's system. In cold weather the air first heated is passed over steam or hot-water pipes before it is delivered to the main conduit, and by switches arranged in different localities the quantity of hot air to be delivered into each room can be regulated.

A combination of propulsion and extraction is most satisfactory in its results. The United States Capitol at Washington is ventilated in this way. The fresh air is taken in by two stone towers standing on the lawns and thence conducted by two subterranean ducts to the basement of the Senate and House. Here are two huge fans, operated by engines. The fan in the House basement is 16 feet in diameter, and is ordinarily run at the rate of 98 revolutions per minute. In winter the air is warmed in the basement. Beneath the seats of the members are gratings, and these are also placed in the galleries and the aisles. Through these gratings air is forced by the fans. The foul air passes up through registers in the roof and is removed by large exhaust fans. Fig. 16 shows one form of propelling-fan. It may also be used for extracting foul air.

Inlets and Outlets. The proper proposition of inlets and outlets is a question that is not settled. Carbonic acid, although heavier than air, is generally carried upward in the diffusion of warm gases in the room, and as a matter of fact is geneally found at the ceiling

in larger quantities than below. For this reason, and to avoid draughts, the prevailing opinion is that inlets should be from 4 to 6 feet from the floor and outlets near the ceiling. If a separate summer and winter arrangement can be made, as might be desirable in

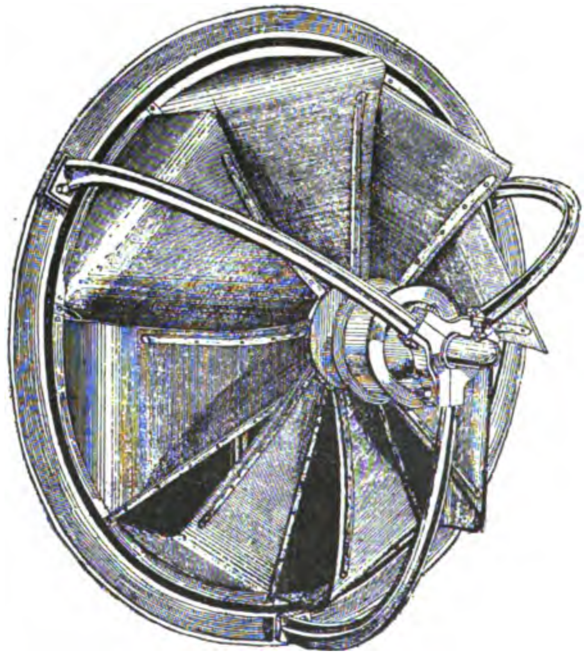


FIG. 16.—BLACKMAN'S VENTILATOR FAN.

schools or public buildings, the reverse order might be adopted for cold weather, as the outlet at the top of the room may carry off heat too quickly for cold weather, while such a rapid escape would be desirable

in warm weather. Figs. 17 and 18 show arrangement of inlets and outlets for the two seasons.

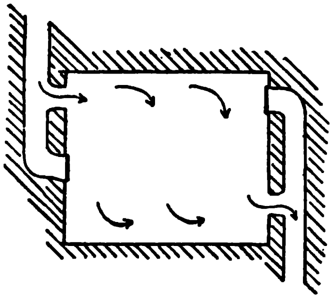


FIG. 17.—SUMMER VENTILATION.

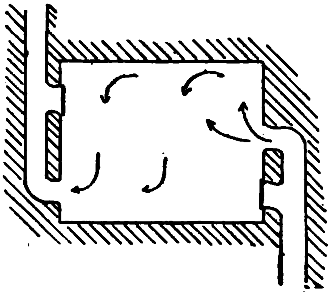


FIG. 18.—WINTER VENTILATION.

The amount of air entering a room through special inlets may be estimated by an anemometer. The instrument is set in the inlet, and the velocity of the air, as it passes through in a given time, will be recorded by the needle on the dial of the instrument. Having obtained the velocity of the current, this is multiplied by the area of the inlet, and we then have the amount of air which a room receives. If we know the cubic space of the room we can tell in this way whether the air is being changed sufficiently often, and also whether the supply is sufficient for the number of persons who inhabit it. Fig. 19 shows the form of anemometer commonly used for this purpose.

In all these methods care must be taken that the fresh air is drawn from a pure source. Whenever practicable the inlet ducts should open twenty or thirty feet above the ground, which is above the

ordinary dust from the street, and below the smoke chimneys and drainage ventilators of houses. With hot-air furnaces this elevation of inlet is not practicable, about five feet being the ordinary elevation for the cold-air box.

All of these fresh air inlets should be provided with some form of air strainer to prevent the dust from entering the house. Cotton wool is the best of these,

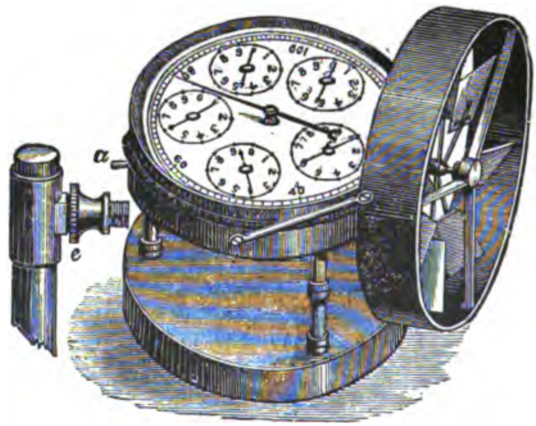


FIG. 19.—AIR-METER FOR TESTING VENTILATORS.

as it will hold back bacteria while admitting air freely. Cheese-cloth is also used. All such air-strainers require to be changed often, as they accumulate large quantities of dust.

In the laboratory of the University College, Dundee, the air-screens, which were 17 feet long by 14 feet wide, collected 2½ lbs. of dirt in seven weeks.

CHAPTER X.

Household Disposal of Garbage and Excreta.

DIFFERENT METHODS.

Methods for disposal of household waste of all kinds differ necessarily with the location of the dwelling. In cities and towns these are under municipal control. In suburban or isolated regions they have generally to be arranged for by the householder himself.

The different methods for disposal of excreta are included under the head of the Wet, or disposal by water-carriage, and the Dry, or the Conservancy System.

I. THE WET METHOD.

In the larger proportion of cities, and almost universally in America, where a sufficient water-supply is available, this method is used to carry off the products of human waste from habitations. The water is generally stored on a large scale in reservoirs and introduced into the houses by one series of pipes called the *supply-pipes*, the liquid waste, including excreta, being carried away from the house in a second series of pipes called *waste-pipes*. This combination of pipes constitutes what is known as *plumbing*. Where a sufficient

water-supply is available this method is at once the most cleanly, effective and convenient of any.

The first municipal Board of Health to carefully investigate the subject of defective house-drainage was that of New York City, in 1875. Their requirements stimulated manufacturers to improve fixtures, and the regulations of New York City have practicably been the model for those of other cities. The requirements for good plumbing as here specified are based upon these regulations.

Plumbing. The supply-pipes are generally of lead, although brass is occasionally used, and these convey the fresh water to various fixtures in the house, such as bowls, sinks, tubs and water-closets. Each of these fixtures has its own waste-pipe which conveys the soiled water and excreta to the house-drain. This house-drain may be considered as one long conduit which runs from the roof of the house to the cellar and thence out to the street-sewer where it empties, but which is called by different names in the various parts of its course. It also varies in size, shape and construction according to its location.

That portion which runs from roof to cellar is perpendicular and is called the *soil-pipe*. It is directly connected with all the various fixtures of the house by means of their respective waste-pipes. That portion of it which runs from the cellar or basement through the house is horizontal in direction with a slight fall of about one-fourth inch to the foot, and is called the

house-drain. Both the house-drain and the soil-pipe are now required by Boards of Health to be made of cast-iron, for reasons of greater strength and so that they may withstand the corrosive action of gases, as lead pipes formerly used could not do. They are made of the kind known as extra heavy.

The soil-pipe should be four inches or more in diameter, and where it joins the house-drain should make an acute angle, in order to facilitate the flow of the contained liquids.

House-drains should also be made of iron. These drains used formerly to be laid with terra-cotta pipes, or sometimes brick drains have been used. The liability of such drains to crack, and consequently to leak both gases and water, with the consequent fouling of air and soil under the house, has led to their being abolished in all newly built houses.

Many of the older houses, however, in most cities have these old-fashioned and most undesirable forms of house-drain. The fact that in most such houses this drain is under the cellar floor, and therefore out of sight, leads to a false sense of security. Cellar floors in such houses have been taken out, and a most filthy and dangerous condition of the soil has been found, in which this is completely saturated for a distance with sewage matter. This state of affairs has been unsuspected until foul odors or certain low conditions of health in the household drew attention to the condition of the plumbing as a possible explanation.

The third portion of the conduit which conveys waste matters to the street-sewer, runs from the outer house-wall to the street and there empties into the main sewer. This is called the house-sewer.

In order that this system shall be convenient and healthful certain requirements must be regarded.

The *essentials* for sanitary plumbing are: First, a plentiful supply of water, sufficient to thoroughly flush and clean the pipes, carrying away all deposited materials. Second, ventilation of the system throughout its entire course, by which means gases are diluted and carried off, and decomposition in the pipes is prevented. Third, the arrangement of all pipes (waste, soil, and drain) in plain view throughout their course, to facilitate examination and repairs. Fourth, the provision of traps, or water-seals, to prevent the entrance of sewer-gas and micro-organisms into the dwelling.

As few fixtures, and as simple as possible, should be arranged for. These should be placed as near to the soil-pipe as possible, so that long runs of piping across floors may not be necessary. It is better not to place wash-basins or other plumbing in bedrooms.

Ventilation is effected by running the soil-pipe in its full diameter six inches above the roof, where it opens to the air, and by providing an inlet for fresh air at the other extremity of the pipe, *i.e.* in the house-drain near the area or street. A current of fresh air will in this way blow through the whole

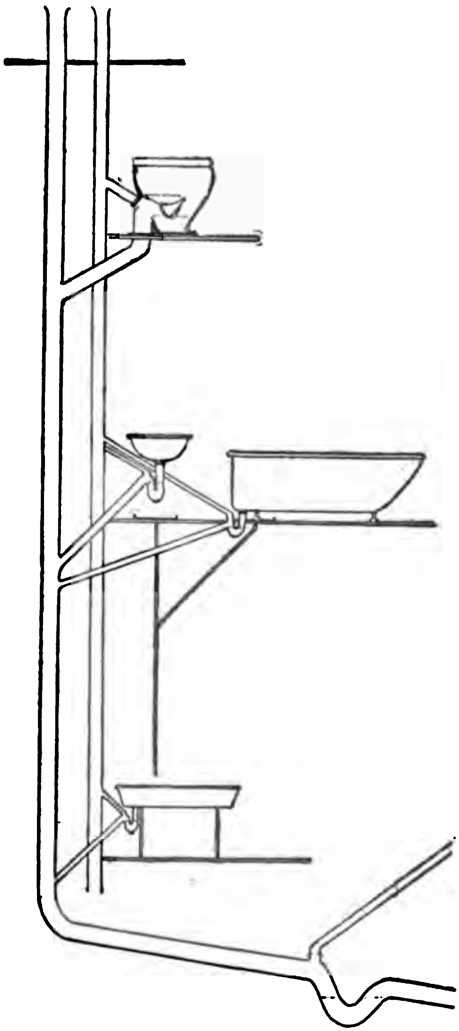


FIG. 20.—SCHEME FOR HOUSE PLUMBING, SHOWING VENTILATION OF SOIL-PIPE, TRAPS AND VENT FOR EACH TRAP.

length of soil-pipe. Reference to Fig. 20 will show these two simple points. It has been found, however, that even with this provision gases and odors sometimes penetrate into the rooms, and obscure cases of ill-health have arisen from these sources which have made it desirable to introduce another safeguard against the admission of sewer-gas. Such a safeguard is known as a *trap*.

Traps. A trap is a bend made in the waste-pipe of every fixture before it empties into the soil-pipe. This bend being of sufficient depth (from 2 to 3 inches) will always retain water in its cavity. The water acts as a seal or barrier to the passage of gases to a large extent, and it is known to prevent the passage of germs. It is called therefore, the *water-seal*. Other devices have been invented not so simple to serve this purpose, but the principle is the same in them all. The seal should be 2 inches deep on water-closets, and no trap is allowed on any fixture with seal less than 1½ inches. Fig. 21 will show the relation of the closet and its pipe with seal to the soil-pipe. Such a trap may be provided with a screw-plug at *B*, by which the trap may be opened, inspected and cleaned in case of stoppage or other difficulty. Such a shaped trap as is shown in the figure is known as an S-trap. Other shapes are frequently used, such as ½ S, ¾ S, or a running trap, the latter being the form used in house-drain in Fig. 20, and other designs. The object of all is to insure a reservoir for water which shall act

as a *seal* against gases and bacteria. Under strong pressure gases may pass through the water, as experiments have detected ammonia in the air passing from

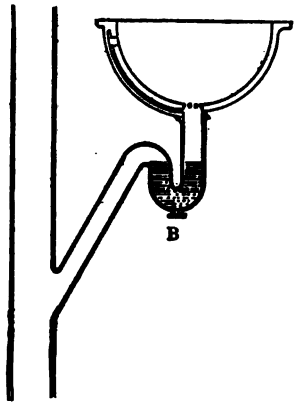


FIG. 21.—TRAP WITH WATER SEAL.

traps. Bacteria, however, which are present in sewage in immense numbers, sometimes of a pathogenic nature, cannot pass through the water, and with a well-planned system of plumbing we are probably safe from sewer-gas.

Waring has invented a valve attachment to the S-trap which he claims is water, steam and gas-tight, and which allows the passage of water downward, but is a perfect protection against a return current from the opposite direction.

A more elaborate trap, shown in Fig. 22, has a ball attachment which by suction applies itself to close the pipe; this is objectionable, as the ball is very apt to

become soiled and cannot easily be cleaned. In this trap *A* is the inlet, *B* the outlet pipe. The escape of gas from *B* is barred first by the water in cup *C*, and second, by the air-ball *D*, which presses against the inlet pipe *A*. As soon as the water ceases to flow down the inlet pipe the ball adjusts itself to the outlet.

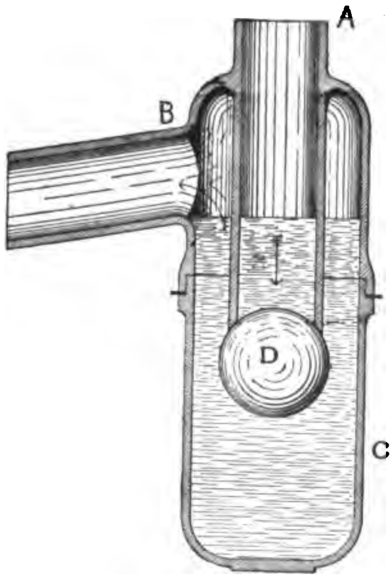


FIG. 22.—BALL AND WATER TRAP—A COMPLICATED FORM OF TRAP. *A*, Inlet. *B*, Outlet.

Most of the other elaborate forms of traps are open to the same objection, and the S-trap is the preferred form.

All closets, sinks, basins, and every water-fixture in the house should be trapped, and the trap should be as near as possible to the fixture it protects.

Loss of the Water-seal. Certain accidents may tend to empty traps, so that the water-seal may be entirely lost. This may happen from *siphonage* or from *capillary attraction.* Whenever a change of pressure occurs in the air of the soil-pipe the water in the traps will be affected, either raised or lowered. Sometimes the water-seal may be entirely lost by this means. If several fixtures on different floors empty into the soil-pipe, the sudden and rapid passage of water and solids from the upper one may cause a momentary vacuum in the soil-pipe which will suck out the water from the traps below. Traps may also be emptied by bits of hair, threads or other materials which may get into them and hanging over their edges may empty the trap by capillary attraction. The emptying of traps from atmospheric pressure is prevented by making for every trap a connection with the outside air. With a single trap this is done by running a pipe from the crown of the trap to the roof, or, if there are a number of traps in the house, by running one continuous pipe through the house above the roof and conducting the separate trap vents into this. Such a pipe is called the *back-air vent*, and its purpose is to equalize the pressure of the air in the waste pipes, and so to prevent the accidents referred to.

Such pipes should be of the same size as the trap (generally a two-inch pipe is used). Fig. 23 shows such a vent-pipe, which is connected with the trap on each fixture.

Although the advantages of having such a vent-pipe are great, for reasons described, there is a great disadvantage attached to its use. Being open as it is to the outside air it favors evaporation from the water-seal, so that the traps may become dry and therefore useless. This actually takes place to such an extent in summer time, when most town houses are vacated, that

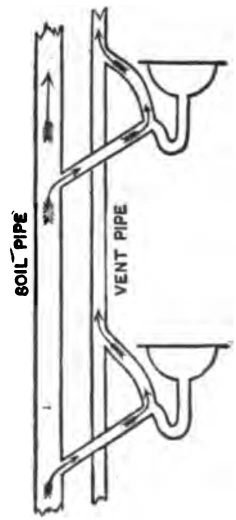


FIG. 23.—VENT-PIPE AND ITS CONNECTION WITH TRAPS.

the traps are often entirely emptied of water. The seal being broken, sewer-gas and bacteria can find easy entrance into the house. It is believed that cases of illness may arise from this condition, as the specific germs of typhoid fever, or possibly of other diseases, may be blown up from the street-sewers into the house

plumbing and so enter the dwelling rooms. If not properly removed from their lodgment about the room they may be inhaled or swallowed and cause infection. To prevent this drying of the traps it is best to have some one enter the house every two weeks and let the water run in all fixtures so that it may be restored to the traps.

As an additional safeguard, all house plumbing should also be disinfected before the family returns to the house after the summer exodus.

So common is this evaporation when traps are back-vented as described, that arrangements for automatic vents have been invented as substitutes for the elaborate system of back-air vent-pipes. The best known of these is McClellan's trap and vent.

This consists of a body containing a light inverted cup, with its edge resting in an annular groove containing mercury, which forms an absolute seal against the escape of sewer air. Fig. 24 shows the vent and Fig. 25 shows it on the fixture.

When a slight diminution of pressure occurs on the sewer side of the cup, the greater external pressure lifts the cup out of the mercury and permits a free inflow of air until the wonted equilibrium is re-established, when the cup drops back into the mercury by gravity, and effectually closes the trap against any outflow. With this trap siphonage of the seal is impossible.

While iron is generally employed for house-drains,

vent-pipes, etc., glass has been proposed as a desirable material for plumbing, and has been occasionally used. It would obviously offer the advantages of transparency, smooth surface and ready inspection, but on

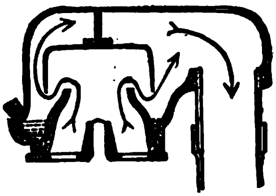


FIG. 24.—MCCLELLAN'S VENT.

FIG. 25.—PERSPECTIVE VIEW OF MCCLELLAN'S VENT IN ITS RELATION TO TRAP AND FIXTURE.

account of its brittleness has not been approved by sanitarians.

The new plumbing in the Capitol at Washington is made of brass, and the anti-siphon trap is used in place of the back-air vent system referred to.

The Fixtures. Water-Closets.—There are several varieties of closets in use. The principal ones are the pan, the hopper and the wash-out closet.

Pan closets represent one of the oldest forms of closet and also the worst. The arrangement is such that perfect cleanliness is impossible, and it is only to

be mentioned as one of the forms that is to be condemned.

Just under the bowl of these closets is a shallow pan containing a little water in which the dejections are received. On raising the handle of the closet, the pan is tilted and the water at the same time is turned on, which washes out the material and sends it down into the traps; but the container, in which the pan is held, is seldom thoroughly cleaned out, and therefore soon becomes very filthy. The closet is highly objectionable from every standpoint.

The hopper closet is one of the simplest and best for general use. It consists of a deep earthenware or sometimes an enameled-iron bowl, with a water-trap directly underneath. The excreta are received directly into the trap and when the water is turned on are swept directly into the soil-pipe. The bowl is washed perfectly clean and there is no elaborate mechanism to get out of order.

Other earthenware or porcelain closets are made with the trap attached to the bowl, and although they are considered more elegant and are considerably used, they do not appear to be any more advantageous than the hopper.

Water-closets, as well as basins, sinks, and the plumbing about laundry tubs, should always be open to view—not inclosed in wooden casing as has formerly been considered necessary. The seat may be of hard wood, varnished, but all pipes, traps, etc., should be

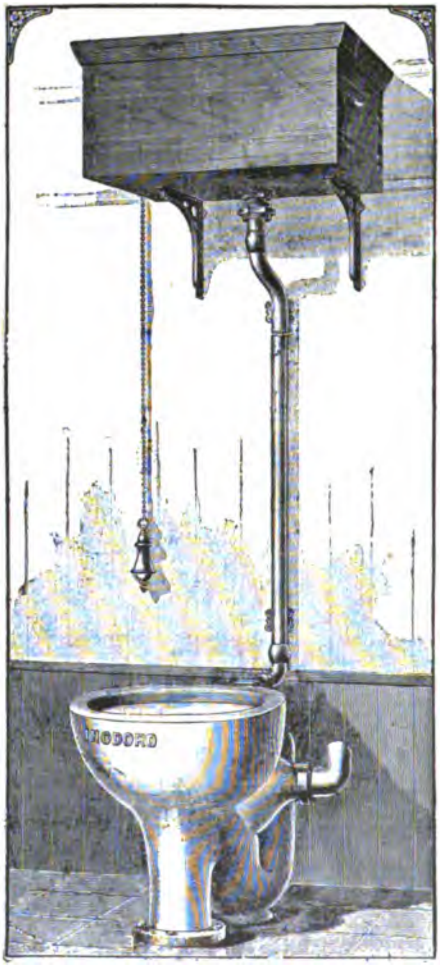


FIG. 26.—CLOSET WITH PORCELAIN TRAP ATTACHED.

exposed. The floor underneath the closet should preferably be tiled, and also the back of the closet. If this is impracticable from the point of expense, it may have a zinc tray under it, and the wood-work be made non-absorbent by varnish.

The water-supply for closets should not be taken directly from the common house supply, but each closet should have an independent supply through a flushing cistern.

Fig. 26 shows such a closet with porcelain trap, tiled floor, etc., the seat is omitted to show the fixture better. The drain-pipe from a refrigerator should never be connected with the soil or waste-pipe, but should discharge into an open water-supplied sink. Cases of poisoning by milk exposed in refrigerators which drained into soil-pipes, as well as cases of infection, have been suspected, and are quite possible under certain conditions.

TESTS FOR GOOD PLUMBING.

Plumbing properly laid, of suitable materials, and with joints well caulked and leaded should be able to bear both the water and the gas test. The water or hydraulic test can commonly only be given by experts. It consists in stopping up the exit of the house-sewer, so that the house-drain can be filled with water. The absence of any leakage is a satisfactory evidence of water-tight drain.

Small cracks, however, may exist that will permit the passage of sewer gases, while they are not large enough to leak water. These may be tested for by an easily volatilized substance, peppermint-oil being commonly used. To carry out this test the soil-pipe must be heated to further the volatilization of the oil. Several pails of boiling water may be poured down the soil-pipe at its exit on the roof. Following this 6 to 12 oz. of oil of peppermint may be next poured down, followed by more hot water. The vent and soil-pipes are stopped up, and the hot-water faucets in all the house-fixtures may then be turned on. Any leakage in the pipes can be traced by the location of the peppermint odor, provided the test is properly conducted. Two persons should be employed to carry it out, one with the peppermint on the roof, the other, who should not have touched the oil, in the house. The roof-operator should not come down into the house for twenty minutes or more, in order not to vitiate the test by the additional odor of peppermint that unavoidably remains about him.

Even if a system of house-drainage is known to be satisfactory, it will require some care to keep it so. The accumulation of grease on the pipes is especially to be avoided. To this end they should have a weekly flush of hot water and soda, or strong lye solution. This should be poured down the kitchen sink, and also into every basin. Rubbish should never be thrown into the fixtures.

The system of house-drainage is connected with the main street sewers by the house-sewer, already mentioned. This is made of iron, tar-coated, or of well-glazed terra-cotta.

Street Sewers. The street sewers are built of brick well laid in cement. All sewer-pipes are laid with a certain fall or gradient, proportioned to their size, in order to facilitate the flow of water. The shape of large sewers is generally elliptical, for the same reason. About 25 gallons of water daily per capita are required for sewage, and the velocity required in the sewers is about 120 feet per minute.

Provisions must be made for the inspection of sewers, as well as for their ventilation. It is also necessary that the entire system be flushed from time to time with clean water. This is especially true where the rain-water is not carried off by the sewers.

Manhole shafts are provided for the inspection and cleaning of street sewers, by which the scavengers can descend. They are constructed of brick-work and are sunk from the level of the road to the sewer below.

Ventilation of the sewers, which is highly important in order to prevent the accumulation of foul gases in excess, is effected by shafts leading from the crown of the sewer to the road above, the opening being protected by iron gratings. Immediately under the gratings a dirt box is placed to catch the mud and gravel. These are generally placed at a distance of from 100 to 120 yards apart in city streets. Venti-

lators are in some cases combined with the manholes. During drought or hot weather offensive smells from these openings are a warning that the sewers require flushing, or cleaning of their interior, which is done by water from the street hydrants.

II.—THE DRY OR CONSERVANCY SYSTEM.

Earth Closets, Pail System, etc. This system of disposal of excreta is naturally adapted to regions where the water supply is insufficient. In these cases, what is known as the pail system may be used, or earth closets are introduced. The contents of these receptacles are removed by the authorities and generally utilized for farm manure.

In many English and German towns the pail system has been substituted for privies or middens. Such pails are made of galvanized iron or tarred oak, generally with a capacity of not more than two cubic feet. They are provided with close-fitting lids, and are removed by the authorities as often as once weekly, empty ones being substituted. They are emptied of their contents at the town depot, are washed with water at a high pressure, and subsequently disinfected with chlorinated lime, or with steam.

The closet provided for them in the house is of the ordinary sort, the pail being simply placed under the seat; the floor should be flagged. House-cinders, ashes, and sometimes dry earth, are used in these pails for deodorization. Decomposition is best prevented

by keeping the contents dry, but when the contents are sold for good manure this is not attempted. When the pail system is used, separate collection must be made of the garbage and kitchen refuse.

In the Goux pail some absorbent material is used to line the pails, such as chopped straw, barn-litter, and other mixtures, which will absorb fluids. Figs. 27 and 28 show the style of pail.

At Hemlock Lake, near Rochester, N. Y., the pail system has been introduced in order to preserve the

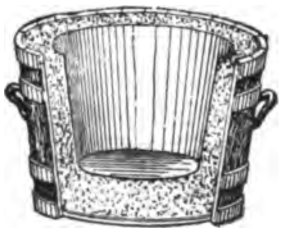


FIG. 27.—LINED PAIL USED FOR GOUX SYSTEM.

FIG. 28.—GOUX PAIL WITH LID ON, FULL TO RETURN TO WORKS.

lake water, which is used in Rochester for drinking purposes, from sewage contamination. It has given good satisfaction.

The *earth closet* is an automatic commode in which dry earth is distributed in proper quantities over the discharges. It is based upon the deodorizing and disinfecting quality of dry earth, and is a possible substitute for other methods, but it is not desirable that

such closets should be placed within the house. When these are used other disposal must be made of the chamber urine, as the system requires that the contents must be kept dry to prevent fermentation. As a substitute for the old-fashioned privy vaults in country regions it is desirable. An improvised closet can be made by setting an iron pail under the seat of the ordinary closet, and providing dried earth in a box with a shovel for use. The value of the compost for manure is not great, but it can be used for garden mould with advantage. It need hardly be said that such closets should never be used in the case of infectious diseases.

Privy vaults have been in very general use both in this country and in Europe, where sewers are either impossible, as in remote country districts, or where ignorance and carelessness prevail. As ordinarily constructed and used, they are highly objectionable from every standpoint. The vault is commonly constructed of wood, which permits ready leakage of the contents into the soil, and they are too often so near the house-well that these liquids, percolating through the the soil, can easily find entrance into the drinking water.

In the event of infectious diseases in the household, such as typhoid fever, cholera, dysentery, etc., such a privy becomes a constant and terrible menace to the inhabitants. History shows that the epidemics of cholera and typhoid, which were characteristic of the last century and of part of this, were due to contami-

nation of the soil and of the drinking water through such means as this.

The only way in which privies might be permissible would be to have them constructed of such material as should render them absolutely water-tight, and to reduce their size so that regular removal of their contents would be necessary. The sides and floor of the receptacle in this case should be constructed of such impermeable material as flagging, asphalt or bricks laid in cement, and the floor of the privy likewise of tiles or other impervious material. It should be, at least, 50 or more feet from any well or stream, and the contents should be removed at frequent intervals (every week or two). This necessity for emptying the vault frequently makes it a nuisance, and there would seem to be no advantage in the use of such a privy over the earth closet or pail system, for these are equally applicable to isolated houses, while its original cost and the disadvantages of removal of its contents are great. Without the precautions mentioned, privies should be forbidden, and even with them it is easy to see how leakage might occur through cracks in the cement or other materials used.

The disposal of kitchen garbage is best effected by burning in the range or stove. Whenever for any good reason this is impracticable, a covered galvanized iron or other non-absorbent can should be provided for the purpose, which should be emptied daily by the city authorities. The cans should be occasionally scalded

out with boiling water and soda. In the country such a can or barrel may be set on wheels and may stand at the kitchen door, from whence such a portion as is not utilized by the farm stock should be wheeled to the general garbage heap. This latter should be destroyed by burning unless it has value for the soil.

CHAPTER XI.

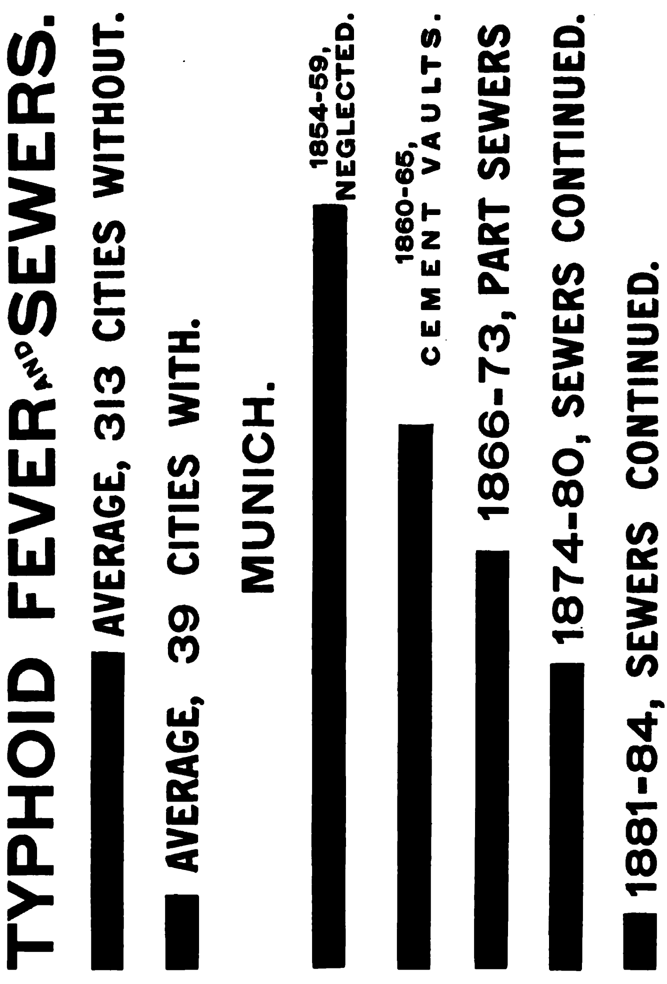
THE FINAL DISPOSAL OF SEWAGE AND REFUSE IN COMMUNITIES.

General Remarks. The question as to the best method for the final disposal of sewage, and also of the other waste matters of a community, has become one of increased importance with our knowledge of the cause of certain infectious diseases.

Public health requires that such final disposal of sewage shall be made as shall prevent its being either a menace to health or a nuisance to the community.

Sewage is now known to be the principal medium for the transmission of certain pathological bacteria, notably those of typhoid fever and of Asiatic cholera, and it is perfectly well understood that these diseases are mainly introduced into communities through sewage-contaminated water. The entozoa may also be introduced into the body of man by this means.

Until within comparatively recent date it has been the almost universal practice for towns and villages located near a river or lake to carry their sewage as quickly as possible to this water-course and there empty it. Cities on the sea-coast can safely empty their sewage into the ocean, provided the sewer-pipes are carried out a sufficient distance to prevent any nuisance from



THE RELATION OF TYPHOID FEVER IN MUNICH AND OTHER CITIES TO PROPER SYSTEM OF REFUSE DISPOSAL.—(FROM "THE ANNALS OF HYGIENE," 1893.)

back-currents during an incoming tide. It is customary to provide an automatic valve for such sewers, which is closed by any such back-current, thus preventing the back flow of their contents into the street sewers of the city.

When the nearest water-course is a river, however, the case is obviously different, as other cities beside the one in question are located on its shores, and will be seriously concerned with its contamination. In many cases such a river may constitute the only available supply of drinking water for the towns on its banks.

The danger of sewage-polluted water has been sufficiently pointed out in the chapter on Water, and bitter experience both in the United States and in Europe has proved the reality of this danger.

Even when the water is not required for drinking purposes the addition of large quantities of sewage to a stream may result in great nuisance to the towns on its banks, as well as in possible danger to health. The banks of such streams may, in time of drought, become very foul, and a nuisance to towns on their margin. Even when no epidemic is present in the locality, isolated cases of typhoid fever or dysentery occasionally occur, the infected discharges from which commonly pass with the sewage into such streams. The self-purification of streams has already been discussed under Water, and it is here only necessary to add that such purification is notably impossible in streams which

are continually receiving fresh additions from the source of contamination.

Several methods have been proposed for the purification of sewage before turning it into streams. Of these the principal are: *Chemical Precipitation*, *Filtration*, *Disruption by Electrolysis*, *Cremation*.

Chemical precipitation of sewage is the oldest of these methods.

In this method the sewage of a town is brought to a central station and run into large tanks or basins. It is then treated with certain chemicals which cause a precipitation of the solid matters to the bottom of the tank. The liquid in its clarified condition is then allowed to flow off into the nearest water-courses, and the precipitated sludge is used for manure.

Numerous chemicals have been used for this purpose, the three which have given most satisfactory results being *lime*, used in form of lime-water or milk of lime, *sulphate of alumina* and *ferric sulphate*.

Lime and alum are frequently used together in proportions of about seven to four grains of each per gallon.

As regards the purifying effect of these chemicals upon sewage it is only partial.

A large proportion of the bacteria present in sewage are destroyed by the process. Investigations of the Massachusetts Board of Health show, however, that from 3 to 5 per cent. of those present remain in the effluent. A large amount of the organic (nitrogenous)

matter of the sewage is destroyed, viz., from 55 to 58 per cent.

These results are obtained at a cost of about thirty cents per capita.

The objectionable appearance of the sewage is removed by this process, and it is said that the effluent offers less favorable food for the growth of bacteria. This method is not intended for localities that use the stream for drinking water, but in certain localities where the streams are not used for drinking purposes this method of partial purification is very acceptable.

The city of Worcester, Mass., has a very large chemical plant for the precipitation of its sewage before it is carried into the Blackstone river. The Blackstone river is not used at any point for a public water supply, and this purification was planned to accede to the demand of manufacturers and others settled below Worcester, for such a purification. The sewage-contaminated river was found to be so changed as to interfere both with the manufacturing of certain cloths, and with the use of the water in boilers. The foul smells arising from this stream below Worcester were also loudly complained of. The plan has proved very satisfactory.

Filtration. The method of purifying sewage by *filtration* is the most important of the different methods mentioned.

It has been found that if sewage is allowed to filter

slowly through beds of gravel or porous soil the effluent passing out will be clarified to a large extent, while chemical and microscopical examination show that in this filtering process the sewage has lost most of its organic matter, and bacteria as well. These effects are due to two processes.

The least important of these is the mechanical filtration of the sewage through the gravel by which the coarser particles are strained out; the second, and most important, is the process of *nitrification* effected through the agency of bacteria, which are brought to the filter in the sewage. Their function has already been described in previous chapters on Soil, Water, etc. They act more effectually if allowed time, and the oxygen used up in the soil has an opportunity to be replaced if the water does not remain continuously in its pores. Therefore the sewage should not be continuously applied, the filter-beds resting at intervals.

Experiments made at the Lawrence Station of the Massachusetts Board of Health show that with *intermittent* filtration the process of nitrification is very active, and 99 per cent. of the organic impurities of the sewage are removed, while the bacteria are reduced on the average to .05 per cent. of those in the sewage, but that if the flow of sewage through the soil is continuous, nitrification ceases and the effluent finally becomes equal in impurity to the original sewage.

The applied sewage in Paris was found to contain 20,000 bacteria to the cubic centimetre, while the

effluent after irrigation contained only 12 to the cubic centimetre. The effluent of filtered sewage contains nitrogen in the harmless form of nitrates and nitrites —the chlorine passes out mostly unchanged. Experiments show that on properly prepared filter-beds the clarified sewage of about 5,000 people (100,000 to 150,000 gallons daily) may be applied to each acre without overtaxing the purifying agencies of the soil. A larger area of land is required if the sewage is previously not clarified. The soil required is rather rich, coarse and porous, and if necessary should be well drained. The land is carefully leveled.

Irrigation, or what is known as sewage farming, is practically an adaptation of the above method with the purpose, in addition to the purification of the sewage, of utilizing the sewage as manure for crops, and in this way to economize its highly nutritive elements for plants.

In these farms a certain area of land is set aside, and after being properly drained is planted with vegetables, or rye-grass. The sewage of the city is then brought to the farms in pipes, is generally there received in settling basins, and the liquid and highly nutritive effluent is then drawn off and distributed by small pipes upon the farm. This farm is practically an enlarged filtration area. The soil for such farms must be porous. The vegetables used are of the succulent variety, such as cabbages and mangolds, alternating with the Italian rye-grass. The amount of land

required is averaged as about one acre to every 100 persons.

There is no evidence that disease is caused by sewage irrigation. Sewage farms have been used in Berlin for many years, and no deleterious results have been traced to them. There is no evidence of distribution of disease-germs by the vegetables themselves, as was at first feared, and as all fresh vegetables should be carefully washed if eaten raw, and otherwise they are cooked before being eaten, any possible bacteria would be eliminated. Evidence is also lacking to prove that sewage-grown produce has, at any time, caused disease in the animals fed on it, whose milk and meat do not differ in the least from that produced on ordinary farms. There is also said to be no odor from these farms, and the effluent from them is very pure, so that fishes live in it.

In England and France many towns have adopted this method of sewage disposal, and the result has been satisfactory. The profit is not great, but differs with the crop grown; that of Italian rye-grass yielding the best returns.

Some difficulty has been apprehended in the cold weather from the freezing of the liquids, but practically this has not been found to interfere with the process.

Electrolysis. Electricity has lately been used to precipitate sewage with considerable success in England. The precipitation is quite rapidly effected, and

it is said that all bacteria are killed by the process. This would seem to offer better results than chemicals.

An electrical plant has been set up (1893) at Brewster, N. Y., a small town on the Croton watershed, where the Department of Public Works has built some sewers to prevent pollution of the New York water supply from this town. No large deductions have yet been published, as the enterprise only proposed to dispose of the sewage of thirty-five buildings.

The Disposal of solid waste by Cremation. In disposing of the garbage and ashes of a community, the separation of the two by the householder is desirable. The ashes, which represent the mineral element of such waste, can then be removed by the city and used for the filling-in of sunken lands, while the garbage proper, which is the putrescible element in such waste, can be cremated.

In all well ordered households the kitchen and other garbage is, or might be, burned in the house, but in every large community this and other garbage (dead animals included) will accumulate, making it necessary for the municipal government to provide some suitable method for their final disposition. Nothing is so satisfactory for this purpose, from the sanitary standpoint, as cremation. Large crematories, or furnaces, have been built for this purpose and are at present in use in different cities of the United States, where they have proved satisfactory. By means of two fires, one at either end of the furnace, the material is burned and

the smoke is consumed at the same time, thereby preventing any offensive odor. Where a good water-carriage system is impracticable, such crematories are well adapted to the disposal of excreta. They were used for the two purposes (of the disposal of ordinary garbage and of excreta) on the grounds of the World's Fair in Chiçago, 1893, and were considered perfectly satisfactory. A detailed report of the experiment may be found in the Sanitarian for December, 1893.

The Shone hydro-pneumatic system of sewerage was introduced on the Fair grounds, by which all the sewage from the grounds was forced by compressed air into large receiving tanks at the cleansing station, amounting in all to about 2,500,000 gallons daily. After treatment with chemicals and the precipitation of solids to the bottom of the receiving tanks, the effluent was run off into the lake and the solids pumped into sewage presses and formed into sludge cakes. These were taken to the crematory to be destroyed. Only a small percentage of this sludge was directly combustible (18 per cent.), the remaining liquids were evaporated, and the ash fell to the bottom of the furnace. The fuel used in this case was petroleum. The cost of the entire process, including labor, was estimated at from 60 to 70 cents per ton.

Crematories are in use in the cities of Savannah (Ga.), Richmond (Va.), Salt Lake City (Utah), Des Moines (Iowa), and many other cities of the United States.

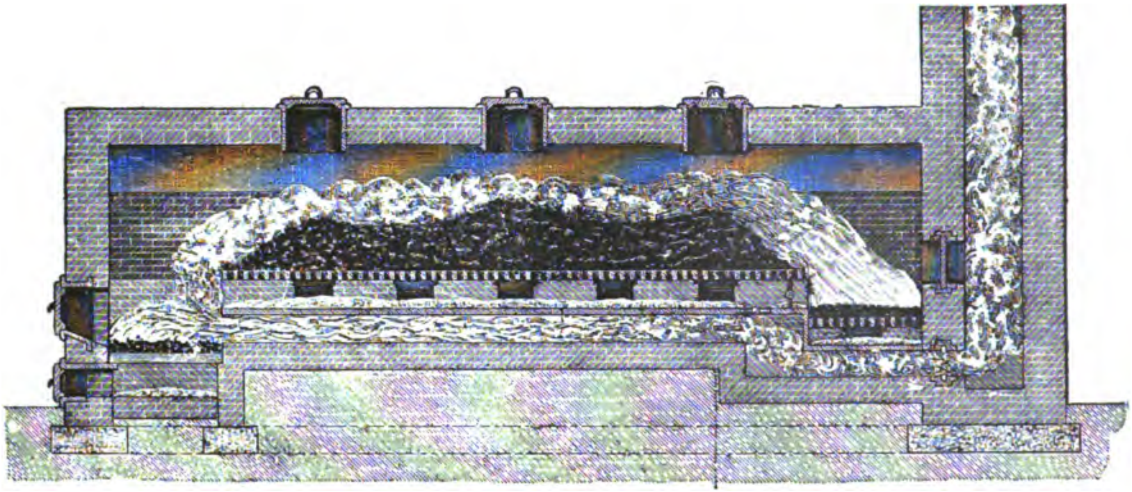


FIG. 20—VERTICAL LONGITUDINAL SECTION OF DES MOINES GARBAGE FURNACE.

In England the practice of disposal of waste by fire has become very widespread and is increasing in favor. It is said to be carried on very cheaply (from 2½ pence to 1 shilling and 3 pence per ton).

Fig. 29 shows the interior of a crematory built for the destruction of garbage in Des Moines, Iowa. The two fires, one from either end, are here seen, and the chimney which draws off the smoke arising from the combustion.

CHAPTER XII.

Growth and Development.

The study of the normal proportions and growth of the human body is of great importance and interest from many points of view, such as the ethnological, the artistic, the medical, and others which can only be referred to in a general manual. These are elaborately discussed in works on anthropometry, such as Quetelet's, Roberts', and others.

There are, however, many hygienic grounds for these studies, of great importance both to the individual and the State. By ascertaining the normal proportions and rate of growth of the individual, we are able to judge how these are modified by nurture and sanitary surroundings, what effect occupation, climate, physical exercise and other life conditions have in accelerating or retarding development, and through such knowledge to approach proper conclusions as to the ideal regulation of life which is necessary to promote the highest physical type of the individual.

No elaborate discussion of this extensive subject will be attempted, but a few of the results of observation in different periods of life will be given. Marked

deviations will generally be found to coincide with ill-health or poor sanitary surroundings.

THE PHYSICAL DEVELOPMENT OF THE INFANT.

Age.	MALE.		FEMALE.	
	Height, inches.	*Weight, pounds.*	*Height, inches.*	*Weight, pounds.*
Birth,	19.68	7.12	19.44	6.94
1 year,	27.48	20.75	27.16	20.00
2 years,	31.14	25.00	30.74	24.00
3 "	34.036	....	33.64	....
5 "	38.8	....	38.34	....

The *weight* of the new-born child diminishes for two to five days after birth, but its original weight is regained after five or ten days, and from that time on is progressively increased. With immature infants or those that are bottle-fed, this period of loss is lengthened.

The greatest gain in height and weight is made in the first year. At the end of the first month the baby should weigh a third more than at birth (from 8¾ to 10⅓ pounds); by the middle of the third month the original weight should be doubled, and tripled at the end of the year (19½ to 21 pounds). Gerhardt's tables (Kinderkranheiten) give the increase in grammes per month; the average is equal to about 1 pound per month.

Weaning may arrest this normal increase, but aside from this a loss of weight in the first year indicates malnutrition, or actual illness. It is probable that

proper nourishment during the first year may affect the height and weight of the adult.

The gain in the second year is less—as seen by tables,—amounting to 5 pounds; two or three pounds are added in the fourth, and by the end of the fifth year the child should weigh about 31 pounds.

Height. With height as with weight the increase is certainly the greatest the first year, amounting to 40 per cent. The lower half of the body grows faster than the upper. The child grows 4 inches in the second year, less in the third, and about 2 in the fourth year.

The Chest. At birth this is 13½ to 14 inches, by the third month it has increased 2 inches. At the age of one year it measures 17 inches, and at the fifth year it should measure 21 to 23 inches. This increase is an indication of normally progressive development. At the end of the third year the periphery of the head equals that of the chest.

The proportion of the *heart* to the rest of the body is largest at about the time of birth, weighing 20.6 grammes; after remaining stationary for a while it takes a new start at about the third month. At 1½ years it weighs 44.5 grammes; at 3 years, 60 grammes. (Gerhardt.)

In general terms, circumstances appear to have little influence upon the size of the new-born. It should also be noted that children are generally born well-formed, any physical deformities and irregularities

being, as a rule, acquired after birth. Chaussier examined 23,000 new-born children, and out of this number only found 122 abnormal states, and these were monstrosities. Faulty conditions both at school and at home must therefore be responsible for the numerous abnormalities found in the bodies of growing children.

The Growth and Proportions of Children. Childhood may be considered to include the period from the age of 5 years to that of puberty. Many different studies have been made of the height and weight of children both in Europe and latterly in America. Dr. Bowditch, of Boston, published, in 1877, the most extensive tables on these two items, having compiled them from measurements of over 15,000 children, from 5 to 19 years of age, in the Boston Public Schools.

GIRLS.

Table showing average height, weight and annual rate of growth of 10,904 girls in Boston Public Schools.

Age.	*Height, inches.*	*Av. Growth, inches.*	*Weight, pounds.*	*Av. Growth. pounds.*
5 years.	41.29	....	39.66	....
6 "	43.35	2.06	43.28	3.62
7 "	45.52	2.17	47.46	4.18
8 "	47.58	2.06	52.04	4.58
9 "	49.37	1.79	57.07	5.03
10 "	51.34	1.97	62.35	5.28
11 "	53.42	2.08	68.84	6.49
12 "	55.88	2.46	78.31	9.47
13 "	58.16	2.28	88.65	10.34
14 "	59.94	1.78	98.43	9.78
15 "	61.10	1.16	106.08	7.65
16 "	61.59	.49	112.03	5.95
17 "	61.92	.33	115.53	3.50
18 "	61.95	.03	115.16	.37

BOYS.

Table showing average weight and height of 4,327 boys from Boston Public Schools. American parentage.

Age.	*Height, inches.*	*Weight, pounds.*	
5 years.	41.74	41.20	
6 "	44.10	45.14	
7 "	46.21	49.47	These weights included clothing, which averages about 2½ pounds, in early life, and from four to six pounds later.
8 "	48.16	54.43	
9 "	50.09	59.97	
10 "	52.21	66.62	
11 "	54.01	72.39	
12 "	55.78	79.82	
13 "	58.17	88.26	
14 "	61.08	99.28	
15 "	62.96	110.84	
16 "	65.58	123.67	
17 "	66.29	128.72	
18 "	66.76	132.71	

Roberts formulates the general facts concerning the growth of children, as follows:

Growth is most rapid during the first 5 years of life.

From birth to the age of 5 years the rate of growth is the same in both sexes; girls being a little shorter in stature and lighter in weight than boys.

From 5 to 10 years boys grow a little more rapidly than girls, the difference being apparently due to a check in the growth of girls at these ages.

From 10 to 15 years girls grow more rapidly than boys, and at the ages of 11½ to 14½ are actually taller, and from 12½ to 15½ are actually heavier than boys. This difference appears to be due to a check in the

growth of boys as well as to an acceleration in the growth of girls incident to the accession of puberty.

From 15 to 20, boys again take the lead, and grow at first rapidly, then gradually slower, and complete their growth at about 23 years. After 15, girls grow very slowly, and attain their full stature about the 20th year. Extensive tables compiled by the British Anthropometric Committee show a slow but steady increase in stature up to the 50th year, and a more rapid increase in weight up to the 60th year, in males, but the statistics of females are too few after the age of 23 to determine the stature and weight of that sex at the more advanced periods of life.

It is probable that the final difference in the height of individuals is chiefly to be attributed to the greater or less development of the body at the time of the accession of puberty; hence the influences which promote or retard the growth at this period are most deserving of study. In boys puberty occurs later, and is less regular and decided than in girls. The transition from boyhood to manhood extends over a period of three to four years, and is accompanied by increased physical development of the body; but girls develop into women in a few months, and with the complete establishment of puberty, growth in height is much diminished, and often ceases altogether.

For a comprehensive study of Anthropometry many other measurements than these referred to are neces-

sary. Some are found in Roberts' Manual. Uffelmann gives additional items for German children, which, however, in some respects do not form a standard of comparison for American children, who are slighter about the hips.

In 1882 the American Association for the Advancement of Physical Education adopted a system of measurements which had already been used in its principal features at Amherst and Harvard, and is now in use in various other American colleges for men and women.

A few items regarding the proportions of young American adults will be selected.

PROPORTIONS OF ADULTS.

Selected items taken from the records of Amherst College, giving the measurements of 1,332 students for the past 30 years, show that the college student of 21 years of age weighs 138 pounds and measures 67.9 inches in stocking feet; that his chest-girth in repose is 35.1 ; full, 36.7 inches; upper right arm, 10.3 inches; breadth of shoulders, 16.9 inches, and lung capacity. 258 cubic inches, gauged by a spirometer.

The *average* student from the same place is slightly below these measurements. Compared with Roberts' tables of English males at that age, the Amherst student is slightly taller (.3 inch) but weighs less by 7 pounds.

Items taken from interesting tables compiled by Dr. Hitchcock regarding the growth of these young

men during their collegiate course show an average gain in structure and function as follows: In bone structure, a gain of 1.31 per cent.; in muscular size, 4.47 per cent.; vital organs, 4.51 per cent.; bodily weight, 7.42 per cent.; muscular power, 24.90 per cent.; the average age of the Freshman being 19 years, Senior 22½ years.

Similar items selected from women's colleges give the following, according to Miss M. Anna Wood: Fifty per cent. of 1,500 young women from Wellesley College at the age of 19.10 years have a height of 63.2 inches; weight, 119.4, chest-girth in repose, 28.8 inches; full, 31.4; waist, 24.6 inches; hips, 35.2 inches; right thigh, 21.6; right calf, 13.3; breadth of shoulders, 14.3; hips, 12.8, and a lung capacity of 150.3 cubic inches.

An average of several hundred measurements taken by the writer from young women at 19.4 years of age, from New York, who have enjoyed the most favorable hygienic surroundings, shows proportions very nearly identical with these, the New York girl being slightly larger in chest-girth.

THE INFLUENCE OF NURTURE UPON GROWTH.

All good or evil conditions of life must have their effect upon the physical development of the individual, particularly those that relate to food, exercise and pure air. Abundance of fresh air, however, generally goes along with exercise, and we shall particularly refer to the influence of *exercise* in promoting development.

Roberts gives extensive tables of English boys and girls taken both from the favored class of the community and also from the laboring class, and a comparison of the two gives startling evidence of the influence of nurture and good sanitary surroundings upon the more evident features of height, weight and chest-girth. Taking over seven thousand boys from the best naval, military and other schools, he finds the mean height at 10 years to be 53 inches, while that of the artisan class at same age is only 50.5 inches. The weight of the school-boy of 10 years is 67 pounds, while that of the artisan is slightly less. The chest-girth in like manner of the favored child of 10 years measures 27.5 inches, while that of the artisan measures but 24.5.

At the age of 18 the favored school-boy measures 68 inches in height, the artisan only 65.5. There is 24 pounds difference in their height, and five inches difference in their chest-girth, both in favor of the school-boy.

Statistics from English Industrial Schools also illustrate the effect of nurture. Children in these schools are either orphans, and hence have probably been denied the fostering influence of parental care, or have been in different asylums and became "institution children," with poor and limited fare, little out-of-door exercise and crowded space indoors. Boys of this class at the age of 14 are 6.83 inches shorter than those of the more favored class, and 24¾ pounds lighter in weight.

No one condition in the lives of these cniidren was more constant than the presence or absence of suitable opportunities for exercise in the open air, and the superior physical type of the boy of the favored class may largely be attributed to abundance of exercise.

The influence of *climate* and *occupation* upon growth is evident from these and other observations.

A town child, moved to the country, almost always increases in stature. Even with adults, Baxter shows that a change of residence from a less to a more favorable climate may result in increased height in the individual. This was shown in the case of many recruits in the Civil War, who were called from a rigorous New England climate to a more favorable Western air, with the result of a marked increase in stature even in cases where the men were apparently fully matured.

There is undoubtedly an hereditary tendency both in races, nations and families, to a greater or less stature with proportional other development, but all observations in anthropometry indicate that the class which is most favored in its sanitary conditions has the advantage in physical development as well as longevity.

The special influence of exercise will be considered in the next chapter, as deserving more extended notice.

CHAPTER XIII.

EXERCISE.

Exercise. The importance of exercise from a hygienic standpoint can only be fairly estimated by recalling its physiological effects upon the organs and functions of the human body. These effects and clinical observations prove it to be one of the most potent stimulators of growth, nutrition and health.

Exercise of some description is the instinct of a healthy child and the habit of a vigorous man. A boy who prefers a book to a game is an anomaly, while adults instinctively feel the need for activity after prolonged physical rest.

This instinct must be regarded as nature's indication of the necessity and value of movements for the body.

EFFECTS OF EXERCISE.

As the physiological effects of exercise upon the different bodily organs form the basis for our belief that it is a hygienic necessity, these will be briefly given here.

Upon Muscle. Moderate exercise increases the size of the separate fibres, renders them harder and less

sensitive to injury, and through the agency of the nervous system these become trained to a readier performance of movements of every kind. Fat in the interstices of these fibres is lessened in amount. Disuse of muscle from enforced rest, as may occur after injury, leaves the muscle fibres soft and flabby, and if the inaction is prolonged, they finally degenerate, and only react under a very strong stimulus.

Excessive exercise of any set of muscles induces hypertrophy, and this may eventually result in stiffness and lessened capacity for activity.

The beneficial changes in muscle-fibre due to exercise are due to the increased blood supply which is called for by muscular contraction, and which results in increased nutrition and growth.

The temperature of voluntary muscles is increased by exercise in proportion to the amount of work performed. The maximum aptitude for contraction is exhibited by human muscle at about the temperature of 40° C. (120° F.).

The reaction of muscle is changed to acid by exercise. The venous blood contains more carbonic acid than ordinarily, showing that active molecular changes are in progress which exercise has stimulated. The excess of oxygen absorbed in a work-day is 8.60 oz. over that in rest; and of carbonic acid, estimated under the same circumstances, 13 oz. more than on a rest-day, the work-day including rest.

This is according to Pettenkofer and Voit, who show

that while in a state of rest the absorption in twelve hours amounted to 708.9 grammes, during work the amount reached 945.5 grammes. For the same period the elimination of carbonic acid was, during rest, 911.5 grammes, during work, 1,284.2 grammes. It is certain that the formation of carbonic acid takes place in muscle to a great extent, as observations show that the amount of carbonic acid passing away from a muscle is in excess of the oxygen passing to it.

We may conclude, therefore, that muscular exercise is one of the great factors in originating metabolic changes in the body.

There is no reason to doubt that the *involuntary* muscles of the body, as in the stomach, intestinal canal, skin, etc., are strengthened by the exercise of their fibres equally with the external, and that the solid muscular structures of the body, such as the heart and the uterus, are improved in functional activity by the physiological processes that are inaugurated by the external muscles. The Oertil and Schweiniger cure for obesity, recognizing the fact that the heart muscle is generally weak in these cases, includes in the treatment exercises which gradually increase the work of this organ, with the expectation of strengthening it in this way.

Functional dysmenorrhea is often relieved by general systematic physical exercise, without other means, and in the experience of the writer this has proved one of the most useful resources for lessening these painful

affections in young women, when not dependent upon organic disease.

The *bones* of the body are evidently influenced by the habit of exercise.

The skeletons of draught horses are much heavier and present more prominent ridges for muscular attachments than do those of horses who lead an easier life.

Connective tissue is presumably rendered more elastic by exercise, as we know that the joints of persons who take much exercise are proverbially more supple and easier in their movements than is the case with sedentary persons. Marked instances of this are circus performers of various kinds, who achieve remarkable suppleness by constant movements.

In proportion to their activity the glands of the body act more freely, as is well illustrated in milk and tear glands.

On the Nervous System. "The functional improvement of the nervous mechanism which represents any movement, automatic or voluntary, is the most important effect of muscular exertion."

If we consider the uses to which we put our body in every-day life, we shall see that most of them require the co-operation of a large number of muscles rather than the tremendous contraction of any one set of muscles.

In walking, in sewing, in carpentering, playing the piano, and many other movements, it is not so much an

expenditure of strength that is needed on the part of the muscles, as it is a skillful co-ordination of their activity by the brain, and in proportion as we are able to co-ordinate at will larger or smaller groups of muscles do we become skillful, ready, dexterous. Physiologists have found that each group of muscles in the body is governed by a corresponding ganglia of motor cells in the brain, and that the contraction of the muscles in question is rapid or slow, perfect or irregular, according to the transmission of nerve impulses from these ganglia through the nerves which connect them with the muscles. The perfection of any movement depends upon the smoothness of this transmission. We may suppose that the oftener the path from the brain to muscle is traveled by a nerve impulse, the smoother becomes the road it has to travel, and the more correct and finished becomes the movement executed. If the nerve impulse is unaccustomed to the road, it may be easily diverted into by-paths and diffused over other areas, giving rise to awkward or irregular movements on the part of muscles not required for the specific action. Such is the picture presented by a boy learning to write for the first time, his feet twisted about a chair, his face screwed into an agonized expression, his tongue between his teeth,—in fact the nerve impulse which should be conducted straight from brain to fingers, diverted into various irregular channels all over the body. Training, *i.e.* the constant repetition of the

movement, results in establishing the co-ordination of a certain set of muscles necessary to the work—and therefore in the economy of force. This co-ordination or co-operation is effected through the nervous system, and hence exercise is a direct training of the nerves and motor ganglia—and therein lies a great part of its value.

Lack of exercise of these ganglia evidently results in atrophy. It is believed that the visual and auditory centres may waste after years of respective disuse, such as may occur after blindness or deafness of many years.

All physiologists are agreed that the centres of motor ideation require to be exercised to promote development. Stammering may be corrected by constant education (exercise or training) of the speech centres.

On the Skin. The skin is generally somewhat reddened after exercise from turgescence of its vessels. Perspiration is increased, in some cases may be doubled, sodium chloride and acids passing off in great abundance. Some nitrogen probably passes off in urea. The excessive evaporation from the skin reduces the heat of the body, so that the temperature generally remains normal, or it may rise a little. Cold does not appear to hinder this perspiration, but it may hinder the evaporation, in which case the bodily temperature is increased, and difficulty and languor on exertion may follow.

On the Heart. The first effect of exercise is to accelerate the heart ten or twenty beats, afterward this rise is lessened, but if exercise is prolonged un-

duly or is severe the heart action may be increased forty or fifty beats, and may become intermittent.

In young persons or weakly, prolonged or excessive exercise may cause dilatation of the heart. One or two instances have been recorded where such dilatation was believed to be induced by excessively long tramps undertaken by young children.

There is no reason to doubt that deficient exercise weakens the heart muscle.

On Lungs. The circulation being hastened by exercise, a larger quantity of air is required to aerate the blood. The lungs, therefore, act more quickly, more air being inspired and a larger amount of CO^2 expired.

If we take 1 as a standard of air inspired during repose, the amounts may be increased as follows:

In sitting,	1.18
Standing,	1.33
Walking 1 mile per hour,	1.90
On horse, walking,	2.21
On foot, 2 miles per hour,	2.76
Gallop,	3.15
On foot, 3 miles per hour,	3.22
Carrying weight, 15 kilometres,	3.50
" " 28 "	3.84
Trotting horse,	4.05
Swimming,	4.33
Walking 4 miles per hour,	5.00
" 6 " " "	7.00

Ordinarily, a man draws in 480 cubic inches of air per minute. Walking 4 miles per hour he draws in 2,400 cubic inches per minute; 6 miles, 3,260 cubic inches.

Excessive exercise may under some conditions produce pulmonary congestion and hæmoptysis.

Digestive System. The appetite is generally increased, especially for meat and fat. Digestion and absorption are both more perfect. The circulation in the liver is apparently improved, and this, with the increased muscular activity of the intestinal canal, often results in removing constipation (improving functional activity). An increased amount of food is necessary after exercise, particularly of nitrogenous and fatty substances, and of salts (especially the phosphates and chlorides).

On the Kidneys. The amount of water and salts may be decreased, owing to increased elimination from the skin. In general, exercise seems to have slight effect upon the elimination of nitrogen, this being generally greater in the interval of rest after exercise than during the period of exercise itself. (Parkes.)

The Effect of Exercise upon Growth and Development. Reference has already been made to this point in the preceding chapter. It is evident that anything which affects the entire organism, as exercise has been shown to do, must be a great stimulater of bodily growth.

As bearing directly upon this question, a few of the results obtained by different observers will be briefly quoted.

From a table of measurements taken by Maclaren of twelve non-commissioned officers selected to be

qualified as military gymnastic instructors, we find the following gains after eight months' training. (The youngest man was 19, the oldest 28 years of age.)

	Weight, pounds.	*Chest, inches.*	*Forearm, inches.*	*Upperarm, inches.*
Smallest gain.............	5	1	1/4	1
Largest gain.....	16	5	1 1/4	1 3/4
Average gain............	10	2 7/8	3/4	1 3/4

In a course of training of 21 youths from 16 to 18 years old, extending over four months, the increase was:

	Weight, pounds.	*Chest, inches.*	*Forearm, inches.*	*Upperarm, inches.*
Smallest gain............	1	1/2	1/8	1/4
Largest gain........... ..	8	5 1/4	1/2	1 5/8
Average gain.............	1 3/4	2 1/2	1/16	1

Chest Development. A noticeable point in the first table is the fact that, although these men might naturally be supposed to have attained their development in this respect, the average age being 24, every man made a good increase, while the largest gain is extraordinary, unless we may suppose the individual concerned to have been greatly in arrears in this respect, for his age.

The following tables, Figs. 30 (*a*), 30 (*b*), 30 (*c*), compiled from measurements taken by Miss M. Anna Wood, of Wellesley College, give interesting evidence of the result of systematic physical training in the case of twenty young women of that institution.

Comparative Tables showing records of Class Crews of Wellesley College receiving training in Gymnasium and on Lake, those of twenty students receiving training in the Gymnasium for six months, and those of twenty students receiving NO training in the Gymnasium.

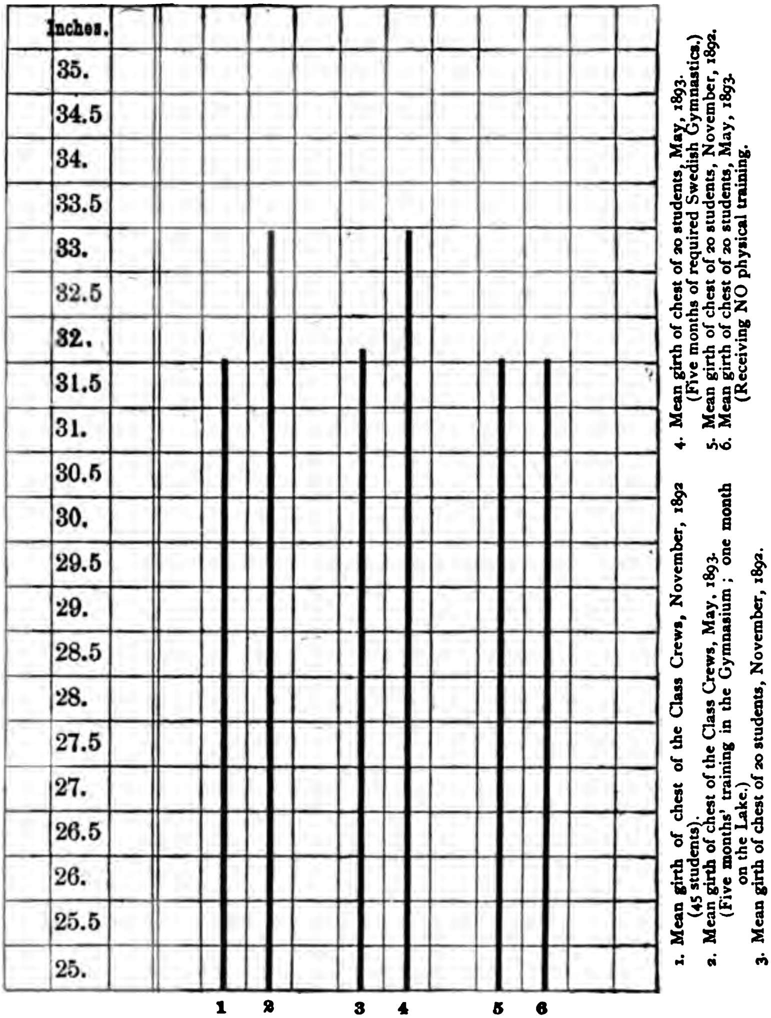


FIG. 30 (a).—MEAN GIRTH OF CHEST.

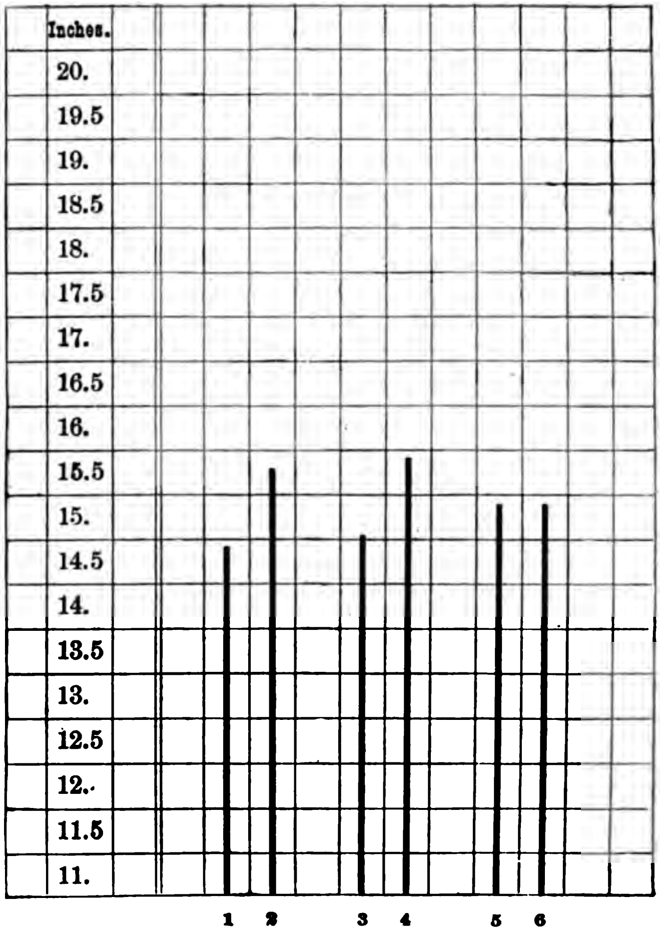


FIG 30 (*b*)—MEAN BREADTH OF SHOULDERS OF SAME STUDENTS UNDER SAME CONDITIONS.

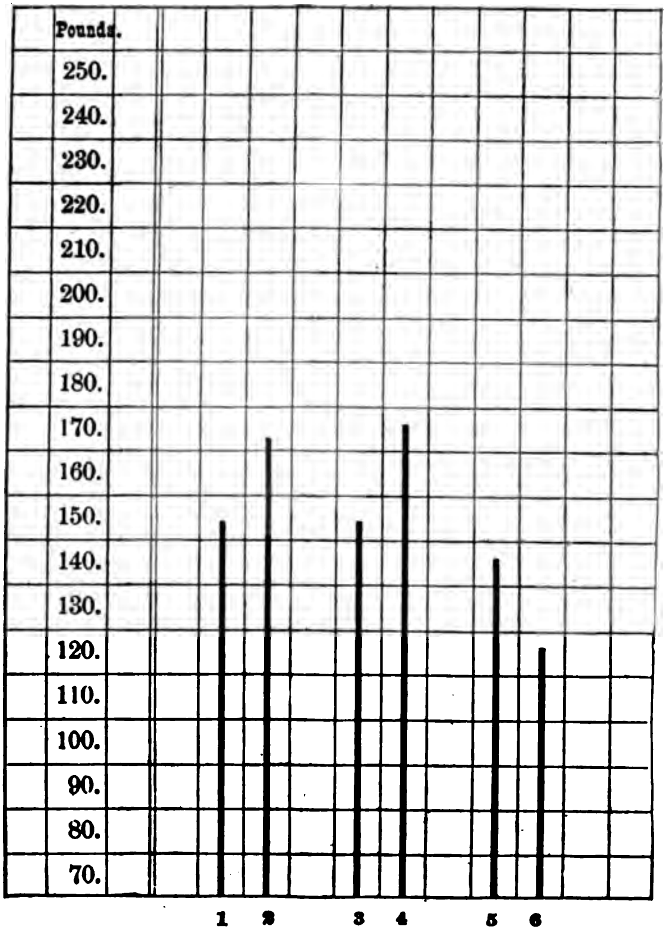


FIG. 30 (*c*)—MEAN STRENGTH OF BACK OF SAME STUDENTS UNDER SAME CONDITIONS.

The following cases from a large number of similar instances under the writer's care and observation, serve to illustrate the influence of exercise upon growth and development, both in the case of children and also in adults.

Case 1.—Girl 12½ years of age. Excellent health and good sanitary conditions in every respect, but below the average height, and growing slowly.

Had systematic exercise in gymnasium twice weekly, and in addition special spinal gymnastics for a beginning scoliosis on the other days of the week. The increase in various measurements taken at the end of seven months were as follows: Height, 2.3 inches; weight, 11 lbs.; chest girth, in repose, 2¼ inches; expanded, 2¼ inches; ninth rib (at attachment of diaphragm) ¾ inch; waist, 1¾ inch; hips, ¾ inch; upper right arm, ½ inch; forearm, ½ inch; breadth of shoulders, ¾ inch; of hips, ⅜ inch; increased lung capacity, 25 cubic inches. The sudden increase in height in this case was marked, and has steadily proceeded to this time. The general increased rate of growth was attributed largely to systematic exercise, as all other conditions of life had been otherwise peculiarly favorable. A younger sister, also lacking in height, took on a similarly satisfactory growth after a similar course of exercise.

Case 2.—Young woman 19 years of age. Favorable environment. Exercised only two hours weekly in gymnasium. At the end of three and one-half months'

time the following gains were noticed. Chest girth, 1½ inches; full, ¾ inch; ninth rib, 1 inch; full, 1¼ inches; forearm, ¼ inch. Strength tests taken by various dynamometers were nearly doubled in back and legs.

The noticeable feature here is the short time in which satisfactory gains were made, and the fairly mature age of the girl.

Case 3.—Woman 37 years of age. Highly favorable surroundings. Exercise, two hours weekly in gymnasium for seven months; occasionally one-half hour in addition. Notwithstanding the fact of full maturity, there was noticeable increase in measurements as well as improved function, as shown by the following: Chest girth, plain, ⅛ inch; ninth rib, 1.1 inches; waist *lessened* by 1.4 inches; hips *lessened* by 2 inches; right arm increase, one-fifth inch; forearm, .6; lung capacity, 30 cubic inches.

The Amount of Exercise necessary for a grown man per diem has been estimated as equal to a walk of nine miles.

In terms of physics it is estimated as equal to lifting 150 tons one foot high daily. The internal expenditure of energy on the part of lungs and heart is estimated as equal to 260 tons lifted one foot. The external work of a mechanic is estimated as equal to from 300 to 500 tons lifted one foot.

It is calculated that man utilizes in these five or six hundred tons about one-seventh to one-eighth of all the force obtainable from food. (Parkes.)

In considering a walk of nine miles as a fair estimate for active exercise required by a man, deduction must be made for the necessary exercise taken in business employments.

The amount of exercise required for women is estimated as equal to that required by boys of sixteen.

Kinds of Exercise. A distinction is necessary between the kinds, as well as the amount, of exercise suitable for children and for adults.

Children require exercise in order to promote their growth and development. Adults, principally to promote the proper functions of organs for the maintenance of health.

Artificial systems of exercise suitable for children should therefore be varied in kind, but not too long continued.

In planning both out-of-door exercises and also those of the gymnasium for young persons, consideration should be given to the fact that the conditions of school-life to which they are subjected tend to dwarf the chest and to favor curvature of the spine, and, therefore, the child requires counteracting influences elsewhere. As regards gymnasium exercise, therefore, while a good gymnastic drill should aim to exercise the entire body as far as possible, special attention should be given to exercises which favor chest and spinal development.

Arm movements in all directions, but especially upward and outward, should have a large share in the

order of the day; while climbing and hanging exercises will also be found useful for young children.

Children should be encouraged to learn and practice all suitable out-of-door games and sports. It is idle to expect them to form a taste for out-of-door life unless they find there some genuine occupation and diversion.

In country regions they should be taught to swim, to climb, to row, to skate and to play croquet, tennis and ball. These games and accomplishments will be limited by their age and strength; but even a mimicry of the games mentioned offers them physical development and mental occupation. The more delicate should be encouraged to undertake gardening and practice walking in gradually increasing distances, and to use the tricycle or the bicycle. Whenever possible horseback-riding should be provided. A country home offers many opportunities for light out-of-door employments and exercise for delicate persons.

The conditions of city life are unfavorable for out-of-door exercise for children except among the well-to-do, who can provide a horse for riding. Walking remains the one universally convenient method of outdoor exercise in cities, and this, by reason of its monotony, and (if long continued) the weariness induced by walks sufficiently long to furnish the amount of fresh air required, are really unsuitable for young children.

Parks should be more numerous in our cities, where

children can run and enjoy skipping, jumping and climbing. The bicycle and the tricycle can be used to some extent by children in such places, but their use is limited by city conditions. All of these means should be employed as far as possible; but considered as exercise for purposes of development (as well as recreation) they need to be supplemented by other more systematic means.

The best practical substitute appears to be a well-ordered gymnasium where fresh air abounds, perfect cleanliness is maintained, and space is plenty. Sunlight should have free admission. The hall should be well supplied with climbing-ropes, ladders and other apparatus which would encourage children to use their arms and legs freely in well-planned imitation of tree and fence-climbing.

Very young children, under eleven, should have separate classes from their elders, in which gymnastic games predominate. Long standing-drills with dumb-bells and similar apparatus should be avoided with these children, as they are physiologically unfitted for them for reasons already referred to. With suitable rests and variations in the exercise, an hour may be profitably employed. After the exercise they should be rubbed dry with a towel, and a dry suit of underwear should be put on. It is understood that a suitable gymnasium costume is worn, which is both light and loose.

Children above eleven may engage in more elaborate

class drills in addition to their games. According to the systems used in teaching these may consist of dumb-bells, wands, Indian clubs and "free" exercises interspersed with gymnastic games, or of movements with or without apparatus as taught in the Swedish system. The respective advantages of the different systems, German and Swedish, need not be discussed here, as experience has proved that both can be made highly advantageous to the pupil under intelligent direction. To have *some* system may be said to be more important than *a* system. A thoroughly competent instructor is a requisite, and medical supervision of the pupils is desirable.

These drills should preferably be held three times weekly, although in many places twice weekly is the maximum time that can be obtained.

Adults can make for themselves somewhat better opportunities for out-of-door exercise in the city, inasmuch as extended walking is for them more possible, and bicycling is also possible both for men and women. Neither of these exercises, however, offers the needed opportunity for free exercise of the upper part of the body required by the sedentary occupation of city persons; and while every possible advantage should be taken of these methods of obtaining out-of-door life, experience proves that adults are much improved in health by adding to these a certain amount of exercise in the gymnasium.

This should vary with sex, age and strength.

Violent exercise should be avoided by persons under twenty, and above thirty years of age. The average adult, man or woman, will gain more by using light-weight dumb-bells and clubs (from 1 to 2 lbs.) and by making use of light chest-weights (from 2½ to 10 lbs.) frequently and systematically, varied with such other work as the director finds individually suited to him, than by the use of heavier weights.

These exercises may be advantageously taken with a class of others of similar strength and capacity. The condition of the heart and lungs and general health of the individual should be inquired into, and with young persons the spine should be examined, and the gymnasium practice be based upon the results. The phlegmatic temperament can be allowed to work longer and harder than the highly nervous. Automatic exercises, *i.e.* those requiring considerable muscular but less mental activity, are indicated for persons mentally overworked; while more elaborate movements requiring skill and quick co-ordination will be useful for the indolent and torpid mind.

The various prescriptions for exercise cannot be given within the limits of this chapter, but should be given by a competent director, based upon a physical examination of the individual.

In many American colleges both for men and for women a preliminary physical examination is compulsory before systematic gymnastic exercise is allowed.

SPECIFIC EXERCISES.

A word or two may be said regarding the value of specific exercises.

Walking is one of the most simple and valuable of the exercises that are taken in the open air. Taken at a good swinging pace in comfortable attire, and in regions where conventionalities do not forbid natural and easy movements of the arms, it is a fine exercise, influencing heart and lungs, and especially developing the lower limbs, and the spinal muscles which keep the body erect.

The trunk does not get its full quota of exercise, however, and at the usual pace and in the manner most persons walk in our city streets it becomes a somewhat purposeless exercise. Children and others should be taught to walk erect, to hold the chest out, and to cultivate an easy gait, and this may be assisted by proper gymnasium training.

Fencing is one of the most elaborate exercises, requiring quickness of eye and brain and readiness of hand, and, in general, rapid and perfect co-ordination of the muscles. It is capable of giving exercise to most all of the body muscles. It is, however, not suitable for the highly nervous, the very delicate or very young. The fatigue experienced is even more in the mind than the body, from the concentration required, and it is, therefore, not suited to young children. According to Lagrange it is capable of de-

veloping a lateral curvature of the spine if persisted in for great length of time.

When given as a class exercise the right and left arm should alternately be used for the foil.

Fencing develops litheness and freedom in movement.

It would seem to be most useful for adults in good health but of sedentary occupation, who are not given to cerebral or spinal exhaustion.

Cycling is a most desirable exercise and addition to the list of out-of-door sports, for several reasons. It takes the rider into the open air where he can enjoy nature under comfortable conditions, and at the same time gives special exercise to the lower limbs, as well as to the spinal and abdominal muscles. The arms also have moderate exercise.

It is an exercise suitable for most men, women and children, and experience appears to show that there are few, if any, necessarily objectionable features in the pastime. Riding for speed tempts men to assume most absurd and unhygienic positions, in which they are bent nearly double, and which induce round shoulders as well as a narrow chest, but except for professionals this position is entirely unnecessary and should be forbidden to all young persons.

Many young, and also many mature women have found in cycling a convenient and delightful method of getting fresh air, exercise and recreation, and although theoretical objections have been urged to

cycling for women, the experience and observation of the writer have failed to demonstrate their truth, and with the large measure of favorable testimony this addition to their too limited list of outdoor sports should be welcomed. Some more suitable dress than the ordinary walking costume will make the exercise easier for women, and will lessen the danger of accidents.

Swimming is particularly desirable for young children, from its influence in developing the chest and back, and giving symmetrical exercise to the entire body.

Rowing exercises the back, the loins, and with the sliding-seat, the legs, but it is far less of a chest exercise than commonly supposed, and the position in fact is not particularly favorable for development of that region.

It is an exercise well adapted for men, women and girls, as the weight of the boat and oars can be varied to suit the individual, and, being adaptable to the strength of each, can be practiced by those who have weak lungs or heart, with due regard to caution.

Suitable costumes for women, loose and light, are especially necessary in this exercise.

CHAPTER XIV.

INDIVIDUAL HYGIENE.

Certain periods of life in the individual require special care, and the food, clothing and exercise required for one of these periods will be found unsuitable for another. Some of these points are taken up in detail under the special chapters devoted to them, such as Exercise and Food. A few additional remarks, however, are called for, particularly with regard to the periods of infancy and childhood.

The normal proportions and growth of the infant are included under the chapter on Physical Development and Growth.

The Infant. Variations in health are easily and quickly induced in infancy, owing to the extreme susceptibility of the tissues to all external influences. The tissues are more vascular at this time than in the adult, and the cells more delicate in structure. The nervous system is extremely sensitive to all irritations.

The normal rate of growth may be interfered with by various conditions surrounding the infant. These particularly refer to its food, clothing and supply of pure air.

Clothing. The ordinary wardrobe of a new-born

infant is both redundant and uncomfortable to the wearer, and interferes with its normal motions. All that is required for the first two weeks is a soft and fine flannel shirt, high-necked and long-sleeved, a diaper, and a soft flannel robe which fastens about the neck and comes below the feet a few inches so that it may cover them perfectly. If the infant is then covered with a soft blanket in the crib it will be properly warm.

Later, when the child is carried about more, a soft flannel sleeveless robe may be used as a skirt and covered with a muslin robe of the same cut but with sleeves. Bands, buckles, pins and strings should be dispensed with. The clothing should come several inches below the feet for warmth, but very long skirts should be avoided. Woolen socks will be necessary for the feet, to be later substituted by soft woolen stockings which reach to the knee.

The clothing may be shortened at five or six months, when the long stockings and soft kid shoes may be worn. A flannel shirt and a flannel skirt are absolute requirements for all infants and young children, the thickness to be wisely adapted to the temperature. In our climate, at least two changes in weight of underclothing are necessary, and three are often required for older children.

Food. The natural and only perfectly suitable nourishment for an infant is mother's milk, and every effort should be made to provide it with this. While the same elements are present in both cow's and mother's

milk, they exist in the two in very different proportions.

Cow's milk contains more solids and less sugar than mother's milk, and these proportions are physiologically unsuited to the digestive canal of the infant, which is extremely sensitive at this time and more easily injured than later in life. Statistics prove that artificial feeding and premature weaning are the two great causes of the appalling mortality among infants in the first year of life.

The direct cause of death in these cases is almost invariably some affection of the gastro-intestinal canal.

Special conditions of the mother, such as syphilis, tuberculosis, marked hysteria or anæmia, should forbid the nursing of an infant.

If the mother is unable to nurse the child an artificial substitute must be prepared.

The best is cow's milk, which must be diluted with water, in the proportion of 1:3, and a little sugar, 4 to 5 parts for every hundred of the mixture, may be added. This should be pasteurized (heated at a temperature of 68° C., as mentioned under Milk), which is better than complete sterilization, as the latter induces chemical changes in the milk. The danger of transmission of disease through milk, especially tuberculosis, is considered under Food, and will be prevented by pasteurization. The first day an infant takes about one and one-half ounces of milk. After this it may have from one and one-half to five ounces of the

mixture in gradually increasing quantities at intervals of three hours; and the interval of two and one-half to three hours should be insisted upon, as regularity in its diet is absolutely essential.

After the first few weeks less food is required at night, and finally none at all.

Starchy foods should not be given to infants, as the ferments which aid starch-digestion are not secreted in sufficient quantity during the first few weeks of life. Saliva, for the first eight or ten weeks of life, has its sugar-forming ferment but slightly developed.

Chemical laboratories now exist in several large cities which prepare cow's milk for infants in proportions either similar to mother's milk, or with fewer or more solids, according to the prescription of the physician in each case.

Weaning. Experience shows that this may well be undertaken about the eleventh month, and it should take place gradually. Cow's milk may then be given in proportions of 2 parts milk to 1 of barley-broth, and the transition may be gradually made to solid food by using meat-broths, yolk of eggs, zwieback, etc. The use of certain of the infants' foods now on the market, which with milk form a digestible food, may be recommended, especially such as have the starch of flour converted into sugar by malt.

Children fed with condensed milk are very liable to digestive disturbances, also anæmia.

The most scrupulous cleanliness of the feeding-

bottle is necessary to prevent possible fermentation. The simplest form of bottle only should be used, made with a round bottom, to facilitate cleaning.

The diet of the child, from two to five years of age, may consist of soft-boiled eggs, meat, and meat-broths, bread and milk, and gradually the simplest vegetables and ripe fruits. Children of this age do not need great variety in diet, and under no consideration should be fed from the table of their elders with bits of dainties, beer, tea or any other stimulant.

The infant should be preserved from the excitement and disturbance incident to much visiting, carrying about, fondling, etc., and be allowed to develop, as do other little animals, in an atmosphere of quiet, and, so far as entertainment is concerned, of judicious neglect.

The Child. The period from five to fourteen, or to puberty, is that of childhood.

As growth at this time is constant and progressive the best of food and a large allowance of sleep are necessary.

As stated elsewhere, children require relatively a larger proportion of nitrogenous food than adults, but do not require a great variety. Meat, the cereals, fruit, and the vegetables, simply but well cooked, should form their diet. Rich soups, pastries and "fancy" cooking should be forbidden.

An early dinner and long hours for sleep (the latter not less than nine, and, in earlier years, ten in number), and at least two hours daily out-of-doors are necessary

for health. Whenever practicable the early years of a child's life should be spent in the country in the open air. This is particularly necessary where there is any predisposition to phthisis, anæmia, or a neurotic temperament.

There need no distinction be made in the *exercise* of boys and girls under fourteen, except such as refers to individual strength.

The *clothing* of girls should be such as facilitates ease and pleasure in movement. The many waistbands, strings and superfluity of skirts commonly worn by young girls should be dispensed with. A warm union-undersuit of wool, warm stockings, and one warm light skirt, with a pair of knickerbockers or other woolen drawers for out-of-door wear, with a wool dress, comprise the necessities for winter and insure freedom and comfort. Light gauze wool underwear should be worn in summer. For further details on this subject see chapter on Clothing.

Young Adults. Both sexes require special oversight and guidance at this period of the establishment of puberty. Out-of-door life, the regulation of exercise, and the provision of mental occupation are necessary, wisely limited to individual strength. The dullness of mind, or conversely the irritability, sometimes seen in young people at this time, are nature's indications that strain should be avoided, both mental and physical, while idleness should never be permitted.

Boys and young men should be encouraged to

practice all kinds of out-of-door sports under proper guidance. The regulation of exercise at this time (both for boys and girls) may properly be made by an experienced medical adviser.

Adults. The special hygiene of adults refers particularly to the maintenance of an amount of exercise sufficient to preserve health, and to moderation in diet. To the absence of good rules in these two respects much of the ill-health of persons over thirty may be attributed. The effect of exercise in improving functional activity has been already referred to. Regularity in this respect is highly important.

CHAPTER XV.

CLOTHING.

Uses of Clothing. Clothing is of hygienic importance as a protection to the body against cold and heat, wind and rain. For the preservation of health the human being must maintain a temperature of 37° C. (98.5° F.). Heat is continually passing from the body by radiation and conduction, as well as through the evaporation of perspiration from the skin. Clothing maintains this loss within safe limits, and it is through his ability to vary his clothing with varying seasons that man possesses his power of acclimatization.

The fur of animals indicates the protective power of clothing in preventing excessive radiation. The sheep after shearing loses from 5° to 6° in temperature, a rabbit shaved, although eating more than usual, loses 8.5° in temperature. A varnished rabbit may die, and although this was originally explained as due to the obstruction of excretion from the skin, it is now thought that death in such cases, is due to the increased radiation of heat, which is greater than the animal is able to bear. In sections of the spinal cord, which involve the heat centres, the enormous

loss of heat resulting is prevented by enveloping the animal in layers of wadding.

The maintenance of the temperature of the body, as affected by clothing, depends upon the *conductivity* of the material, its *porosity*, and its power to absorb liquids, known as its *hygroscopic quality*. These qualities differ in different textile fabrics.

The materials chiefly used by man are wool, cotton, silk and linen. Leather is used to some extent, especially in arctic regions, and india-rubber for protection against storms.

It is calculated that ordinary clothing lessens the loss of heat from 20 to 40 per cent., depending on the material.

The *physical appearance* of these various materials under the microscope differs greatly, one from the other. Wool fibres are round and occasionally interrupted by cornet-striations. In old woolen fibres the canal is flattened. Silks, cotton and linen have flattened canals; in cotton the fibrillæ are sometimes twisted; in linen they are finer and present little swellings or nodes. These distinctions, as well as those obtained from testing the chemical reactions, are principally useful in discovering frauds in military stations or other localities where raw materials are purchased on a large scale.

Conductivity. Considering fabrics from the standpoint of their quality as good and bad conductors of heat away from the body, linen is known as the best

conductor, consequently is the coolest material for wear. Cotton stands second, silk third. Wool is the best non-conductor, consequently the warmest material.

This quality in clothing depends upon the amount of air which is present in the meshes of the material. Air is an excellent non-conductor, therefore loosely woven fibres and elastic materials, like good woolen fabrics which afford space for air, are warmer than tightly woven linen which contains fewer air-spaces. It is probable, therefore, as suggested by Poore, that the weaving of the goods, and not its peculiar fibre, is the principal factor in its conductivity or otherwise, and that by improvements in weaving other materials than wool will eventually be as useful.

Absorbent Quality. The *hygroscopic quality* of clothing, especially of material used for underwear, which should absorb perspiration freely, is very important. Water is a good conductor of heat, therefore wet underclothing will conduct heat away from the body rapidly, and in this way expose the wearer to sudden and dangerous cooling of the surface. The absorbent property of wool is double that of other materials, and the garment does not therefore get *wet through* easily, and does not feel wet to the body until it has absorbed an immense amount of water. Also, while wool absorbs water freely it gives it off slowly, and in this way prevents chilling of the surface.

The extreme variability of our American climate renders wool the most desirable material for underwear

at all seasons, and as it is manufactured in many different weights suitable for all seasons, it can be worn with perfect comfort as well as great advantage to health in warm and cold weather alike.

After exercise evaporation is constantly going on from the wet skin. The putting on then of a dry woolen undergarment is attended with a sensation of comfortable warmth. This is due to the fact that the vapor of perspiration is condensed in the wool fibres, and in the change from liquid to gaseous form heat is emitted, and is stored in the meshes of the cloth.

The case is different with cotton, which is a poor absorbent. Perspiration, therefore, lies on the skin and on the surface of the garment, and the constant passage of air over it carries off heat and gives the wearer a sensation of chilliness which if prolonged may be serious.

In the same way a damp atmosphere moistening clothing conducts away the heat from the body and induces chill.

Silk and linen are better absorbents than cotton, but pure silk is seldom found in garments, being "weighted" with various minerals.

New garments are warmer than old, because they contain more "residual air" in their meshes. For this reason the handing down of old and thickened under-flannels to young children is to be deprecated.

Two layers of clothing are proportionately warmer

than a single layer of equal weight, for the reason that the layer of air which is between the two layers of clothing is not constantly being removed, carrying a large amount of caloric with it.

Color. As a protection against heat, color rather than texture is important. For hot climates those colors should be selected which absorb the heat rays least. Experiments show that if white be considered as 100, light yellow is 102; dark yellow, 140; light green, 152; red, 168; black, 208.

It is desirable that in our warmer States men should abjure black hats and dark clothing and use the lighter colors during the warm weather. This would particularly apply to workmen and other persons directly exposed to the sun's rays who, by reason of their calling, are liable to sunstroke. Their clothing should also be loose.

Protection against fire has been partially accomplished by impregnating the materials with ammonium phosphate and sulphate. The material does not wear so long, however, when treated in this way.

Leather and india-rubber are necessary in arctic regions or where winds are extremely severe; the latter should be worn as little as possible, as it induces condensation and retention of perspiration.

The coloration of clothing by arsenic, nitrate of mercury, etc., and other powerful chemicals, is undesirable. Sometimes vesicular eruptions and other signs of irritation and poisoning of the skin have

arisen from this practice. Vegetable coloring matters should be substituted when possible.

Woolen garments have the objectionable quality of absorbing odors, and for this and other reasons should be frequently aired and shaken. Bacteria also naturally adhere more readily to rough surfaces, a point that should be borne in mind by the physician or attendant in cases of infectious disease. In such cases the attendant should wear cotton (washable) materials, and the physician may well have an ample linen duster or sleeved-apron to throw over his woolen clothing on entering the sick-room.

The Form of Clothing. The *form* or shape of clothing has hygienic significance because of its power to constrict the body and limit the physiological functions of circulation, respiration, etc.

In many uncivilized races, as well also as among the Greeks and other early civilized people, the habit of wearing a band about the waist and, with women, under the breast, has been always practiced. Even these comparatively elastic bands may restrict respiration to some extent, as shown by Dr. Fitz in his observations upon the different races in the Midway Plaisance at the World's Fair, 1893. He noted that a single tight band, even a string tied about the waist, changed the normal respiratory rhythm, as recorded by the pneumograph.

The corset, however, of comparatively modern times is pre-eminently the constrictor of respiration,

and imposes a limitation upon the activity of the diaphragm and the development of abdominal muscles which is of unquestionable influence for evil upon the health of women.

The belief was formerly accepted that the costal type of respiration which prevails with women was nature's provision for gestation; but observations upon women of savage tribes, as well as upon the lower classes of civilized nations, where women do the work of men, show that the abdominal type of respiration is as marked with them as with men. May's observations upon Indian girls, and Kellogg's upon Chinese and Indians, as well as upon working-women who have never worn corsets, amply demonstrate this fact.

It is also known that the type of respiration in the female of the lower animals is the same as that of the male. Fig. 31 includes a few of the tracings taken by Kellogg, showing marked abdominal breathing in the unrestricted Chinese and Indian women, similar to the men of their race, with very marked differences in the type of breathing between civilized men and women, when the latter had worn corsets.

Kellogg's and other experiments show that the constrictions of modern dress seriously interfere with the action of the diaphragm in respiration, and by pressure upon the abdominal walls both weaken and tend to displace the pelvic viscera in a downward direction.

He found the average pressure exerted at the waist by a tight corset or bands, to amount in ordinary

FIG. 31.—SERIES OF RESPIRATORY TRACES BY KELLOGG, SHOWING TYPES OF BREATHING IN MEN AND WOMEN UNDER VARIOUS CONDITIONS OF FREEDOM AND RESTRICTION IN CLOTHING, ALSO LIKENESS OF TYPE IN MALE AND FEMALE DOG.

Costal. **Abdominal.**

Man.

Costal. **Abdominal.**

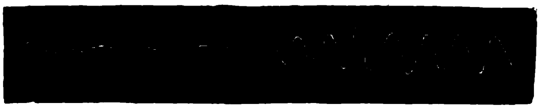
Civilized Woman (Unmarried, age 33 years).

Costal. **Abdominal.**

Chinese Woman.

Costal. **Abdominal.**

Indian Man (Chickasaw).



Costal. **Abdominal.**

Indian Woman (Chickasaw).

Costal. Abdominal.

Young Woman in Corset.

Costal. Abdominal.

Man in Corset.

Costal. Abdominal.

Male Dog.

Costal. Abdominal.

Female Dog.

respiration to .3 inch of mercury. In forced respiration he found the pressure to range from 1 to 20 inches, equivalent in pounds to from one-half to ten pounds per square inch. These figures are only suggestive of the force exerted. Naturally, a very tight corset would increase this pressure, but the pressure would not be equally great at all places.

The oscillations of the diaphragm are highly important in their influence upon abdominal circulation, as well as on respiration. If in addition to curtailing both of these, the muscular structures are weakened and their supporting power lessened, the evil results on the health of women must be far-reaching.

A comparison between the working and the leisure

classes of women of almost any civilized community, *e.g.* the French and the German, as regards endurance and vigor, would indicate that the enervating influences of civilization are responsible for the difference, which in respect of strength is always in favor of the former.

The general principle that clothing should not interfere with the physiological functions of the body, either in man or woman, does not admit of question.

In the dress of men tight collars, vests or bands of any kind should be eschewed. It would be desirable that their headgear should be better ventilated.

With women the corset should be substituted by one of the numerous waists now in the market, if any support is required, and the weight of clothing be avoided, and its easy fit guaranteed by the use of union-underwear, the reduction in number of skirts worn, and the fashioning of dresses, either in one piece according to many beautiful models now made, or their support on properly fitting waists.

The Shoe is a common source of discomfort and deformity. This is not surprising when the shape of a natural human foot is compared with that of the ordinarily pointed shoe. Ellis points out the fact that the effort to make each foot look like a separate symmetrical whole, is opposed to its anatomy and interferes with its functions. The inner line of the human foot from heel to toe is almost straight; the outer line is distinctly curved. Any shoe that forces the foot into a position where the two sides look symmetrical

must therefore force the great toe to describe a portion of a circle, which throws its first joint into prominence, and transmits the weight of the body to it, instead of allowing it to be diffused along the entire inner line of the foot and toe. The evil results of improperly made shoes are well known to include painful and deforming affections of the foot. The functions of the foot are interfered with, and not only does locomotion become painful, but it must also lack ease and elegance from the æsthetic standpoint.

The subject is scientifically dealt with at length by Ellis in his monograph on The Human Foot.

In general, it may be said that shoes should be made to order, from a last which is the actual shape of the free foot. The inner line should therefore be a straight one; there is no reason why the outer line should not be curved at the toes; the leather should not be stiff, but soft and pliable, the sole moderately thick.

Heels are not necessary, but if worn, should be low. A high heel throws the foot forward, bringing the body weight on the big toe. It also, as pointed out by Ellis, prevents the foot from going down, the necessary preliminary to springing up, which is its most important movement from a functional point of view.

Children should not wear heels of any kind, neither should their shoes be too heavy, as weight and stiffness interfere with perfect function. An extra cork sole

made in the shoe should be preferred to unduly thick shoes.

Socks and stockings may well be made with a separate stall for the big toe, although one with a straight inside line will suffice. The ordinary medium-pointed toe is only an additional evil to the pointed shoe. Fig. 32 shows proper forms of socks. Stockings as

FIG. 32.—PROPER FORM OF SOCKS (ELLIS).

well as all clothing, woolen undergarments particularly, should be thoroughly aired, as the organic matter of the perspiration which they absorb is readily oxidized by free contact with pure air.

Wool socks, of varying degrees of thickness, according to weather, are considered most desirable by many on account of the porosity of the material and its absorbent qualities.

CHAPTER XVI.

BATHS.

The desirability of bathing for cleanliness needs no advocacy among civilized nations.

The usefulness of cold or cool bathing for invigorating purposes, and as part of the gymnastics of the skin, may, however, be further insisted upon, as well as the duty of communities to provide means by which baths for cleanliness may be made possible among the poorer classes.

Cold Baths. A cold bath is not cleansing, as the fatty and other organic matters which accumulates on the skin are not soluble in cold water. Tepid or warm baths (from 85° F. to 98° F.) are therefore desirable, once at least, and with children probably twice weekly. The hot bath is partly a therapeutic measure, and is not particularly desirable for most persons, as it is apt to leave a sensation of lassitude.

In addition to the necessary bathing of the person referred to, all persons not having an idiosyncrasy in the matter should accustom themselves daily either to a cool sponging of the entire body or a cold plunge bath. The cold plunge is a tremendous stimulant to the skin and the entire economy. The respiration is

temporarily hastened, or is deeper, the pulse is slowed. The skin is temporarily chilled, the temperature is sometimes reduced 2° in the axilla and cutis anserina appears, but after emerging from the bath a reaction occurs in healthy individuals which induces a feeling of great warmth. The skin is then reddened, and the heart soon resumes its natural beat. In vigorous individuals who react thoroughly to this stimulus, the cold bath is highly refreshing and strengthening. Persons, however, who are in delicate health, or who do not react well, or who have a good reaction at first, followed by a second sense of chilliness later, should omit this practice and confine themselves to the cold sponge-bath.

The latter is probably the most universally applicable. Those unaccustomed to it should begin with water at the temperature of a comfortable room (68° F.), and gradually use it cooler, until able to draw it directly from the cold-water faucet in winter.

All forms of bathing should be followed by vigorous friction with a rough towel. By the cold bath, and also by cold sponging, the excretion of CO^2 is increased —as is its production also, the increased excretion continuing after the bath for a time. Cold bathing also increases the conversion of fat. These baths are not applicable to the aged.

Turkish and Russian baths are really therapeutic measures, although they are indulged in by many simply as a luxury. As such they cannot be repeated too often by the average person with impunity.

Soaps should be pure and free from the more caustic alkalies. The transparent soaps are presumably always purer than the others, as impure fats will not form a clear residue with alcohol in the process of making.

Pure castile soap is one of the best of the opaque soaps, and may be preferred for infants and children. Impure soaps irritate and roughen the skin.

Public Baths. Baths for the poor should be provided in every city. Cleanliness with them is very nearly allied to godliness, and the limitations of their crowded houses seldom offer them opportunity for frequent bathing.

The form of indoor bath most practicable for this purpose is the rain-bath, something allied to the shower but placed lower down and at such an angle that the water falls freely over the entire body. The temperature is capable of regulation in the bath-room.

These rooms should be floored with asphalt, cement or other impervious material, and should be so slanted that the water may run off easily into the drain below. The walls should also be of impermeable material or finish.

The bather on entering the bath-house receives a towel and a small cake of soap. With this he soaps his body thoroughly and then turns on the rain-bath, which thoroughly washes the entire body surface in an extremely short time. The arrangement of the bath-room referred to prevents any opportunity of contracting contagious diseases from previous bathers.

The cost to each person is from 5 to 10 cents in New York City.

Such bath-houses have been furnished in several places in New York City and elsewhere. They have been common in Germany for some years, and are exceedingly valuable as a hygienic and invigorating provision.

Free salt-water baths are also provided in various cities, but the conditions are not so wholly satisfactory as in the rain-baths referred to.

CHAPTER XVII.

School Hygiene.

This subject deserves special consideration for several obvious reasons. The conditions of school-life concern a special class of the community, and one which from its age and constitution is peculiarly susceptible to unfavorable influences of every description.

It is moreover exposed to these influences for a long period of years, and, statistics show, is more or less affected for life in certain directions by their quality. By reason of its numbers and activity, it is liable to spread infectious diseases, when these exist in its midst, throughout the entire community.

For these and other reasons, the construction of school-houses and the regulation of school-conditions should be planned with intelligence and humanity, and vigorously supervised as to their perfection by sanitarians and educators, not by politicians.

The Building. The first requirement for school hygiene is a well-planned building, in which space, light and heat are intelligently provided for. The essentials in these matters have been already discussed in the chapters on Air, Ventilation, Heating, etc. It is only neces-

sary to repeat that overcrowding means vitiation of the atmosphere and increased dust from the movements of large numbers of children, with all the illeffects that result from these conditions.

The *air-space* necessary for each child should be at least 600 cubic feet, and 800 should be given if possible. Each child should have an allowance of floor space of from 50 to 90 feet, and 1,800 to 2,500 cubic feet of air per head should be supplied every hour, the smaller quantity to the youngest, the larger to the older pupils.

All large buildings should be ventilated by mechanical means, already described under Ventilation.

If practicable, the outlets and inlets provided respectively for foul and fresh air may be arranged according to the plan for summer and winter ventilation in Figs. 17 and 18. If mechanical means are not used for ventilation, a fireplace in each room will act as an efficient extractor of foul air, provided a window or other fresh-air inlet is kept open.

The *heating* of a school may be effected by hot water or steam, preferably the former. In small buildings furnaces are allowable, subject to the conditions already mentioned. School-rooms are generally overheated, either because poor apparatus is supplied or from inattention. The temperature should not be allowed to rise above 70° F.; and if the air is dry and the room exposed to the sun, a temperature of 68° F. will be found satisfactory in most cases.

The location of the building should be such as to

insure a plentiful supply of light and pure air. Public school buildings have existed in New York City in which the windows which furnish the source of pure air open directly on to piggeries, barn-yards and other reprehensible quarters, whence foul odors have continually polluted the air of the school-room. Such a condition should be impossible under proper sanitary supervision.

Play-ground. The space about the school-house should be sufficient for a play-yard for the children, allowing three square metres space per pupil. In the country these proportions may be indefinitely increased, and horticultural attractions may well be added.

The use of dark basements or improved cellars should never be tolerated for play-rooms, but such rooms are the only provision made in some schools for this purpose.

The means for insuring dryness of the soil and of the house-walls, already described under The Dwellings, should be carefully regarded in these buildings.

Staircases should be easy of ascent, the steps from 14 to 15 cm. high, and if long should be broken by landings.

The walls should be tinted pale green or pale yellow in place of the staring white in general use, which is distinctly trying to the eye.

The Size of the Rooms. The length need only be limited by the vision and lungs of the teacher. The width must be limited by the necessity for perfect light, which cannot be equally distributed to all pupils if the

room is too wide, inasmuch as proper lighting requires that the light enter from the left side. Trélat fixes the suitable width as between 6.5 and 7 metres.

Lighting. Improper or insufficient lighting is believed to be a great source of myopia and other optical difficulties, hence special attention should be given to this point.

Light which comes from behind is, of course, intercepted by the person, whose shadow falls upon the page in front. If it enters from the front it causes a contraction of the pupil by which the quantity utilized is really reduced. Entering from the right side the hand (in writing) constantly shadows the page, hence the provisions for windows should be made for the left side of the room, and pupils seated in accordance with this rule.

There would seem to be no objection to lighting by a skylight from above if necessary. In this case the seats of pupils should face north. The windows should not be too near the floor, as the angle at which the light strikes the eye is important. Light should first fall on the book or work and so be reflected into the eye.

Loring estimates that each pupil should have an amount of light which would equal a pane of glass 14 to 17 inches square.

Diseases of School Life. It is beyond question that school conditions are responsible for much of the sickness among children, as well as for the develop-

ment of certain serious functional affections. The diseases to which school children are particularly liable are: First, certain infectious communicable diseases, such as measles, diphtheria, scarlet-fever, small-pox, whooping-cough, also ophthalmia.

Second, functional diseases, as myopia, headache, dyspepsia and anæmia. These, it should be noted, do not generally appear until the school age, or previous to seven years.

Third, certain degrees of deformities, pre-eminently that of lateral curvature, also minor abnormalities of chest or other portions of the figure, induced by faulty positions in chairs and at desks, which are incorrectly designed.

The various means by which infectious diseases are spread have been fully discussed in another chapter, and it will be readily understood that communication through clothing, dirty hands, the hair, books, and dust brought in on shoes from infected localities, will be particularly easy under school conditions.

Towels may retain and communicate infection, particularly in cases of ophthalmia.

These diseases once brought to the school-building through the agencies referred to, are easily disseminated there owing to several local conditions very common in public schools.

First of these is lack of cleanliness in the building. Second, lack of ventilation. Third, the absence of proper arrangements for disposing of clothing.

The proper cleansing, scrubbing and dusting of walls, floors, seats, etc., is seldom efficiently performed. The walls of older buildings become coated with dirt, which is doubtless often of a pathogenic nature. In the poorer schools, walls are seldom if ever wiped off. Floors are scrubbed, but the dusting is commonly done with a feather duster, by which the dust is only dissipated from one resting-place to another, not removed from the room, and is easily stirred up again by the movements of the pupils, and may be inspired or swallowed.

Transmission through clothing is facilitated by the bad provision made in many schools for the disposing of the outer garments of the children. In certain schools in New York City the cloak-room is merely a dark and unventilated closet with a long bench, upon which the children throw their coats and wraps, often wet.

Such conditions are highly favorable to the preservation and distribution of any pathogenic organisms that may be brought to the school on clothing.

To Prevent the Introduction of Infectious Diseases into Public Schools. The rules of the Board of Education of New York provide that when such diseases occur in more than one floor of a tenement house, children from that house shall be excluded from school. Where the disease is small-pox or scarlet-fever they shall be excluded if but one case has occurred in the house.

In the case of scarlet-fever the child shall not return

to school until three weeks after the last case has disappeared; after measles, not for two weeks; after diphtheria, one week. If the pupil himself has the disease he is to be excluded in case of small-pox, scarlet-fever and whooping-cough, two months. After diphtheria special precautions are also needed, as the bacteria of the disease may remain in the mouths of the patients for some time after the membrane has disappeared. Every trace of the membrane should have disappeared and disinfection of the mouth and nose should have been practiced before allowing the child to return to school.

Similar provisions should be enacted in all regions where public schools are held. Children having ophthalmia should be excluded until cured, and even mild cases of eye diseases should be referred, if necessary, to free dispensaries for proper treatment.

It is very desirable that competent medical inspectors should be detailed for all public schools in America, with authority to require the proper hygienic conditions of the building, and also to personally inspect the throat and eyes of pupils, with reference to excluding them from school on the first appearance of any suspicious symptoms.

Functional diseases. Myopia is called by Arnoud pre-eminently a school malady. Even when hereditary it generally does not show itself until the child begins to use books, viz., the eight or ninth year.

Cohn, who examined 10,000 pupils in Breslau in

1865, reported that myopia existed least in the rural schools, and that the number of cases increased as the curriculum grew more exacting, attaining its maximum in the gymnasia. Also that it increased regularly from the lower to the higher classes in all schools.

At Madgeburg, 75 per cent. were found myopic; at Erlangen, 80 per cent.; while at Heidelberg he reported 100 per cent.

Agnew and Derby, in America, found from 16 to 27 per cent. of school children myopic.

Myopia is believed to be induced, first, by insufficient light; second, by wrongly constructed furniture, in which the relation of chair and desk is such that the eyes of the pupil are brought too near the page, thus establishing that (permanent) degree of near accommodation found in the disease.

The wide prevalence of the affection in Germany is attributed by some observers to the Gothic characters of the language, which are trying to the eye.

The remedy lies, first, in the provision of sufficient light; this is further discussed under the head of the School-building. Second, the provision of chairs and desks, which are so constructed that the proper position of the pupil is insured, both in reading and writing. The details will be referred to under School Furniture.

Lateral Curvature is considered by many observers to be largely dependent upon faulty positions assumed in school.

The chair may be either too high or too low in

relation to the desk, and is seldom constructed so as to support the back. It is also liable to be too broad from before backward for youthful proportions. The result is that the child must lean forward in order to see well, especially while writing, and generally rests on one elbow, sitting on one buttock.

In this way the spine is thrown into a position of dorsal curvature. The chest is seriously contracted by many of these positions, and myopia is favored where the proper distance from chair to desk is not obtained.

The position required in English schools for writing the "English hand," has been considered by foreign hygienists as responsible for the large percentage of curvatures found in these schools.

Bradford and Lovett examined the spines of a large number of Boston children and reported 160 out of 200 children as having a spinal curvature with the convexity in the lower dorsal region; the pelvis was obliquely twisted; only 38 sat in the correct position, viz., with the transverse axis of the body parallel with that of the desk.

School Furniture. The general faults in the construction of school furniture are that the chairs are generally too low, and the tables or desks too high. Also that the chairs do not conform to the shape of the back, so as to give it proper support.

Chairs should be so made that they will support the lumbar region of the spine, following its natural curve,

so that the pupil can sit back with comfort in a position where the transverse axis of the body is parallel with the desk.

The chair must be of such a height as will permit the feet to rest firmly upon the floor, or upon a bench.

The seat should be wide enough to support three-fifths of the posterior part of the thigh.

The horizontal distance between the chair and desk should be nil; the chair should advance under the desk two and a half to seven centimetres.

The following rules for the correct proportions of the chair are from Bradford and Lovett:

Chairs. Height from seat to the floor—6 to 9 years, 33 cm.; 9 to 12, 37 cm.; 12 to 15, 41 cm.; adults, 47 cm.

Height from seat to middle of lumbar projection, at same ages: 21 cm., 23 cm., 25 cm., 27 cm.

The Desk. The distance from the top of the seat to the top of the table should be one-eighth the height of a girl, and one-seventh the height of a boy. Fig. 33 gives an outline of the proper relation of chair to desk. If school-benches are used, they should have a support for the hollow of the back.

Children should also be trained to write in the position referred to, viz., with the transverse axis of the body parallel with that of the desk. If the school furniture is comfortable, this can as well be learned as the usual method of sitting sidewise with the right elbow leaning on the desk, and of itself would prob-

ably prevent some of the unsymmetrical development that appears in children after fourteen. Adjustable chairs and desks are now in the market, which can be raised or lowered to suit the height of the individual.

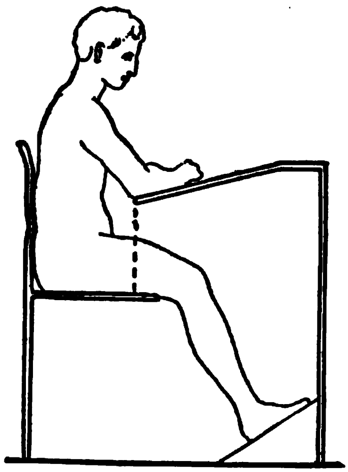


FIG. 33.—OUTLINE OF RELATION OF SEAT AND DESK.

Books. The hygiene of the eye demands that attention be paid to the printing of school-books. The paper may preferably be of a soft yellow tint, or cream, as being less trying to the eye than white.

The length of the lines in a school-book should not exceed three and one-half inches, for the same reason; longer lines weary the vision. The type should be clear, and of size known as "small pica."

The distance between the eye and paper or book should never be less than twenty-five cm. (fifteen inches). With less space there is bending forward of

the head, and abbreviation of the space between the retina and the desk.

Systematic physical exercise should form part of the regular school curriculum, and should be taught by trained instructors.

Recesses should be frequent for young children, who suffer from the immobility required from long hours. Children under eleven should not remain in school more than three hours.

CHAPTER XVIII.

INFECTIOUS DISEASES, THEIR CAUSE AND PREVENTION.

An infectious disease is one that is due to the invasion and growth of specific pathogenic micro-organisms in the body.

The theory that certain diseases were due to some unseen but real entity, whose presence in the body gave rise to the symptoms, has been dimly conceived of for many years. It has remained for the microscope and the researches of the laboratory to demonstrate the truth of this conception, and to bring before our eyes the actual living organisms which induce certain definite diseases.

The conditions which Koch states as necessary for such demonstration are:

1. That the specific micro-organism must be found in the blood or tissues of the man or animal suffering or dead from the disease.

2. That this micro-organism can be isolated and cultivated in artificial media for any required number of successive generations.

3. That a pure culture when obtained and inoculated into a susceptible animal must reproduce the same disease.

4. That in the blood or tissues of the inoculated animal, the specific micro-organism must again be found, and must have induced similar lesions to those found in animals infected in the ordinary way.

The chain of evidence is regarded as complete with respect to a certain number of the infectious diseases common to lower animals, and in a few cases similar inoculations have demonstrated the truth in man.

The principal diseases which have been proved to originate from a specific microbe are cholera, typhoid fever, tuberculosis, diphtheria, anthrax, tetanus, relapsing fever, pneumonia, erysipelas, suppuration and leprosy, puerperal fever, gonorrhœa and glanders.

In certain other diseases the specific microbe has been disputed, but clinical evidence has rendered it altogether probable that certain forms of bacteria are the cause of these diseases.

The *communicability* of the infection from man to man differs greatly in this class of diseases. All are alike induced by a specific pathogenic micro-organism, but all are not communicable. Malaria, for instance, is now known to be one of the infectious diseases, as it is induced by the entrance of the plasmodium malariæ into the body of man; but malaria, as is well known, is not a communicable disease from man to man. It is evidently favored by some local conditions of the soil and of the atmosphere of certain localities, which conditions favor the growth of the specific organism of the disease. No amount of contact with a

case of malarial fever can communicate this disease to an individual. Malaria, therefore, is a type of an infectious disease which is *not communicable.*

There is another class of infectious diseases, of which typhus-fever, scarlet-fever, small-pox, whooping-cough, etc., are well-known types, which *are communicable* in the highest degree, in which simple proximity to those infected with them may suffice to communicate the disease to others.

These diseases are known as *contagious* diseases, and are evidently communicated by some atmospheric agency, the infection being generally due to inspiring the infected air about the patient. Simply breathing the same atmosphere with a patient is usually sufficient to induce these diseases in man.

A third class of infectious diseases, however, is also *communicable*, but *not at all contagious.* Of these, tuberculosis and typhoid fever are types. Simple proximity to a case of typhoid fever will not communicate the disease, provided the stools have immediately been disinfected; nor will residence in a room with a tubercular patient induce the disease in another, provided the sputa or other discharges, which contain the specific bacillus, have been destroyed. The infectious agent is not present in the atmosphere in these cases as it is in a case of small-pox or scarlet-fever, but is carried by intermediate means of communication.

General Classification of Infectious Disease. A classification of infectious diseases may therefore be

made, in accordance with these facts, into those that are communicable and those that are not, while the communicable class may be still further divided into those that are contagious and those that are non-contagious, with types of each, as follows:

- INFECTIOUS DISEASES.
  - NOT COMMUNICABLE.
    - Malaria,
    - Yellow-fever,
    - (Generally accepted), etc.
  - COMMUNICABLE.
    - CONTAGIOUS.
      - Smallpox,
      - Typhus.
      - Scarlet-fever,
      - Measles, etc.
    - NON-CONTAGIOUS.
      - Tuberculosis,
      - Typhoid-fever,
      - Cholera, etc.

Immunity. The subject of individual predisposition to or immunity from disease is a complicated one, which science has not yet been able to wholly explain.

Permanent or total immunity in man to the diseases common to the human race probably does not occur. Small-pox once taken is seldom taken again, also one attack of measles or whooping-cough generally renders one immune; but there are exceptions to these rules.

Escape from a prevailing disease is not necessarily immunity. There is evidently a predisposition to certain diseases on the part of families, species, and races.

Race. We know, for instance, that the colored race is more immune to yellow-fever than the white, but

more susceptible to small-pox, and probably other race immunities occur. *Species.* While many of the diseases which affect man also affect the lower animals equally, a few exceptions have been proved. Cats, dogs and pigs are immune to anthrax, so are the frog and the fowl. *Sex* is evidently a predisposing element. The mortality in infectious diseases among men is greater than among women relatively to the number of cases, diphtheria and whooping-cough being the only exceptions to this rule. To these two diseases females appear to be more susceptible than males. *Age* is another predisposing cause.

Both sexes are much more susceptible to the acute infectious diseases before the age of fourteen than after.

Family tendency or susceptibility to certain diseases is also very marked in some cases. What was formerly considered as hereditary, in the case of repeated cases of tuberculosis in many families, is now believed to be an inherited susceptibility of the bodily tissues to the invasion of the tubercle bacillus. The *bacillus is only rarely inherited*, and could the individual be kept in an atmosphere where the germ did not exist, he could not have the disease.

Resistance to this and other diseases can evidently be cultivated as well as diminished on the part of the cells of the body.

It is believed by many that certain cells in the body have the ability to absorb and kill invading pathogenic bacteria, and possibly to digest them afterward, and that

this is one of the means by which the body resists bacterial diseases. The cells which are presumed to do this are called *phagocytes*, and the process *phagocytosis*.

In any case, resistance to disease evidently resolves itself into a question of the vigor and activity of the cells of the body.

The predisposition of the body to disease is greatly influenced by such elements as climate, food, occupation, exercise, etc.

Malaria is one of the infectious diseases in which climate seems to be influential. It is more rife in warm and moist regions where vegetation is abundant, and the soil is more or less damp. The drainage of large areas of country in which the disease has been prevalent, has resulted in immense reduction in the number of cases.

The resistance of the body cells to phthisis in those who have a predisposition to this disease, has also been found to be greatly increased by residence on dry soils and a clear, bracing atmosphere, such as invite to out-of-door life. The relation of phthisis to dampness has already been referred to in chapter on Soil. Occupation has certainly a marked effect in predisposing to this disease. Sedentary occupations, and those involving stooping postures or the breathing of dusty or otherwise irritating air, have a notably unfavorable influence in increasing the tendency to this affection.

Predisposition to disease is also notably affected by the quality and quantity of food, the ill-fed subject

being always more susceptible to infectious as well as to other diseases, while exercise can be shown to have a remarkable effect in improving the vigor and functioning of the body, and lessening its susceptibility in general to unfavorable influences. Exhaustion of the body-cells has also been proved to exert a marked influence in predisposing to infectious disease.

The Spread of infectious diseases may be affected by various agencies which may carry or retain the specific organisms.

(1). *By the Air*, in which the microbe may float in the form of dust derived from various sources. This may be inhaled or swallowed, and so infect the patient. Tuberculosis is mainly disseminated by atmospheric dust, the bacillus being usually inspired, although other methods of infection are possible (see Tuberculosis). Infection from out-of-door air and dust is rare; much oftener it is the air of dwellings that is responsible.

(2). *By Water* which has been directly or indirectly contaminated by the discharges of persons suffering from infectious diseases, as river water into which the bowel discharges of cholera and typhoid-fever patients have been thrown, or into which they are carried by sewers. The washing of soiled linen in streams has given rise to epidemics. The contamination of well-water from privies and similar sources is very common, and has been referred to as a frequent cause of infection.

(3). *By Clothing.* The germs of disease may find lodgment on clothing, and be rubbed off on the hands of the person, and from his hands find their way into food or drink, or be directly transmitted to the mouth. Laundresses who handle infected clothing in time of epidemic frequently contract the prevailing disease in this manner. Certain diseases may be carried to great distances in clothing or in other articles, known as *portable fomites*, and may act as fresh centres of infection when opened in uninfected regions.

(4). *Food* is less often a direct source of infection, *i.e.* the substance of the food itself. Germs may drop from the air in the sick-room as mentioned, upon food, or the handling of foodstuffs and fruits by persons with soiled hands may contaminate the food. The infection of the substance of meat, however, as well as milk, may occur when these are taken from tuberculous cows. The infection may result from watering otherwise pure milk with infected water, or from washing the milk cans in the same water, or from the soiled hands of the dairy-people, who themselves have an infectious disease.

(5). *Various Other Sources.* All eating and drinking utensils (as in scarlet-fever, diphtheria) the bed and body-linen of the patient (cholera, scarlet-fever, typhoid-fever), books, pipes, musical instruments, the hands, hair and beard of physicians or attendants (as in the exanthemata), the sputa (tuberculosis, diphtheria) and mucous discharges in certain cases—are

capable of transmitting disease. The hangings of rooms, also carpets, and upholstered furniture, may catch bacteria when floating in the air and may in this way become sources of infection.

The Prevention of Infectious Diseases includes the sum-total of the defensive measure that we can employ to arrest the spread of and stamp out these diseases.

These measures may be considered as both general and special.

The general measures lie in the direction of the diffusion of knowledge regarding the cause of communicable diseases, and other matters of public and private hygiene, already referred to in the introductory chapter.

The special measures are included under the head of Disinfection and Isolation, which will be discussed in the following chapter.

CHAPTER XIX.

DISINFECTION—ISOLATION—QUARANTINE.

The special measures for arresting the spread of communicable infectious diseases are: (1) *Disinfection.* (2) *Isolation.* The extent to which these special measures should be carried out will vary with the communicability of the diseases in question, and will therefore not be equally applicable to all infectious diseases. For the entire communicable class Disinfection will be required; but Isolation will only be called for in the case of such communicable diseases as are also contagious.

Disinfection. By a disinfectant we mean an agent that will kill the specific germ of a disease. This agent is often confused with an antiseptic, and also with a deödorant. An *antiseptic* arrests the development of germs, and may also prevent odors which may arise from putrefactive processes, but it does not necessarily kill the germs of disease. Preservatives, such as cold, salting and the exclusion of air, are allied to antiseptics in their effects upon organic substances.

A *deodorant* will absorb or break up or otherwise overpower the malodorous gases which result from

the decomposition of organic substances, but such an agent is generally only an undesirable mask to conditions which require more radical measures.

Disinfection may be accomplished through several distinct agencies, of which the principal are *Heat* and *Chemicals*. Sunlight and fresh air are also disinfectants, but in most cases these require supplementing by other means.

DISINFECTION BY HEAT.

Heat can be applied in several forms. (1) By fire. The articles may be totally destroyed by burning. (2) By moist heat, applied as steam or boiling water. (3) By dry heat.

Fire. The destruction of infected articles by fire is naturally limited to worthless materials or to localities where expense is not considered. Old bedding, soiled bandages and infected books are satisfactorily disposed of in this way, and we may also use this means for the destruction of tuberculous sputa. Various discharges, mixed with sawdust or paper, may be disposed of in this manner.

Crematories, such as described in the chapter on the Disposal of Refuse, are adapted to this purpose for public disinfecting stations, one being used by the New York City Board of Health.

Dry Heat. Dry heat is also somewhat limited in its application. The disadvantages of dry heat (applied in sterilizing ovens or other apparatus) lie in the fact that

the heat penetrates slowly into the interior of large bundles of goods, and also that in the case of delicate fabrics the long exposure necessary is very likely to injure the fabric. These two considerations make it a less useful agent for institutions and hospitals where large bundles of goods are to be disinfected at one time. Dry heat will change the fibre of cotton and linen after two hours of exposure at 125° C. (257° F.) and colored articles lose their color after two hours' exposure at 105° C. (220° F.).

Vegetative bacteria are killed by an exposure of from 1½ to 2½ hours at a temperature of 100° C. When spores are present, the disinfection may require a higher temperature and longer time.

Articles that have been exposed to dry heat should be allowed to regain their hygrometric water before being brushed or beaten, to prevent loss of substance.

Dry heat is used advantageously in connection with steam heat for disinfection.

Disinfection by Steam and Boiling Water. In these agencies we have the most useful and practicable method of disinfecting, as the heat, in these forms, is both easy of application, does not spoil fabrics exposed to it, and is absolutely effective when correctly managed.

Apparatus for household disinfection by steam may be improvised, as suggested by Flügge, in the following way:

A cask should have one end knocked out and the

other perforated with a number of holes. The open end is set over a vessel of boiling water, and the articles to be disinfected should be hung inside the cask on a framework. The escape of steam about the base can be prevented by wrapping cloths around it. Such a piece of apparatus could be used several times.

The Arnold Steam Sterilizer, which was originally devised to sterilize infants' food, is very useful in the sick-room or in hospitals for the sterilization of small articles, bandages, aprons, and instruments. Some physicians make constant use of this apparatus when attending cases of infectious diseases, slipping off the cotton gown or large apron which they put on on entering the sick-room, and leaving it in the sterilizer for disinfection.

For disinfection on a large scale in hospitals and public institutions, patented apparatus abounds in the market.

In all public institutions a disinfecting chamber should be provided, floored with cement, and with hard-finished walls. This should be divided by a brick partition into two rooms, each with separate entrances. The disinfecting apparatus may consist of a large iron tube, circular or oval in form, one-half of which is in one compartment, the other passing through the brick wall into the second room.

The disinfector has two doors, one opening into each room. Its walls are double, so that steam may be admitted into the interspace thus formed and heat the

articles in the tube without wetting them. Dry heat is generally first applied until the contained articles reach a temperature of 100° C. (212° F.) so that the steam which is then let in may not condense upon the articles.

Another provision against condensation is made by roofing the disinfector with thin iron plates like shingles, which catch the moisture and carry off any excess to the floor of the chamber. The articles are hung up within the disinfector, or shaken out and arranged on racks provided, so as to offer every opportunity for contact with steam. They are put into the disinfector by a man provided with cap and overalls of canvas or linen, and with rubber boots; and when disinfected, are taken out in the other compartment by a second employee.

Two oil-painted carts should be provided; one to carry the infected clothing to the station, and the other to carry the disinfected clothing away from it.

Small objects are disinfected in half-an-hour's time at a temperature of 100° C. (212° F.). More bulky ones require from two to three hours. With a temperature of 110° to 120° C. (230° to 248° F.) with steam under pressure, shorter time is allowed; viz., five to ten minutes for small articles, fifteen to thirty minutes for large articles. The estimates here given intentionally err on the safe side. Freeman's table shows that disinfection can be effected in less time in a moist

medium, but in giving rules for public disinfecting stations, liberal time allowance is desirable.

Portable disinfecting apparatus is also made use of, by means of which a steam disinfector made on similar principles, is put on wheels, in order that it may be

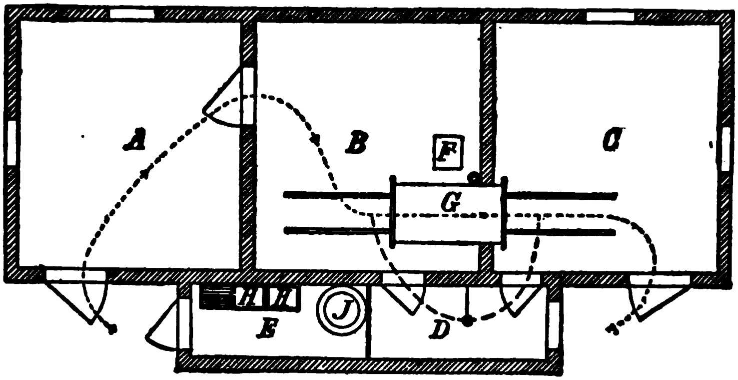


FIG. 34.—OUTLINE OF DISINFECTING PLANT IN BERLIN.—(FROM PFUHL AND NOCHT.)

A is the ante-room where infected clothing or individuals are received, and thence conducted into *B*, the disinfecting-room proper. Here clothing is taken off and placed by the attendants in the steam disinfecting chamber, *G*. At the expiration of the time allowed for disinfection the door of the disinfector in room *C* is opened and the clothing taken out. The dotted line shows the direction taken by an individual who must be disinfected, who passes from *A* to *B*, leaving in the latter place his garments, and thence to *D*, a bath-room. After bathing he enters *C*, where he receives his disinfected clothes. *E* is a sterilizing-room ; *J*, a boiler ; *H H*, sinks.

taken about to houses which require disinfection of goods. Fig. 34, from Pfuhl and Nocht, is an outline of the disinfecting plant in Berlin; and Fig. 35 shows the arrangement of the disinfecting-room or tube proper, indicated in outline only, as G, in Fig. 34.

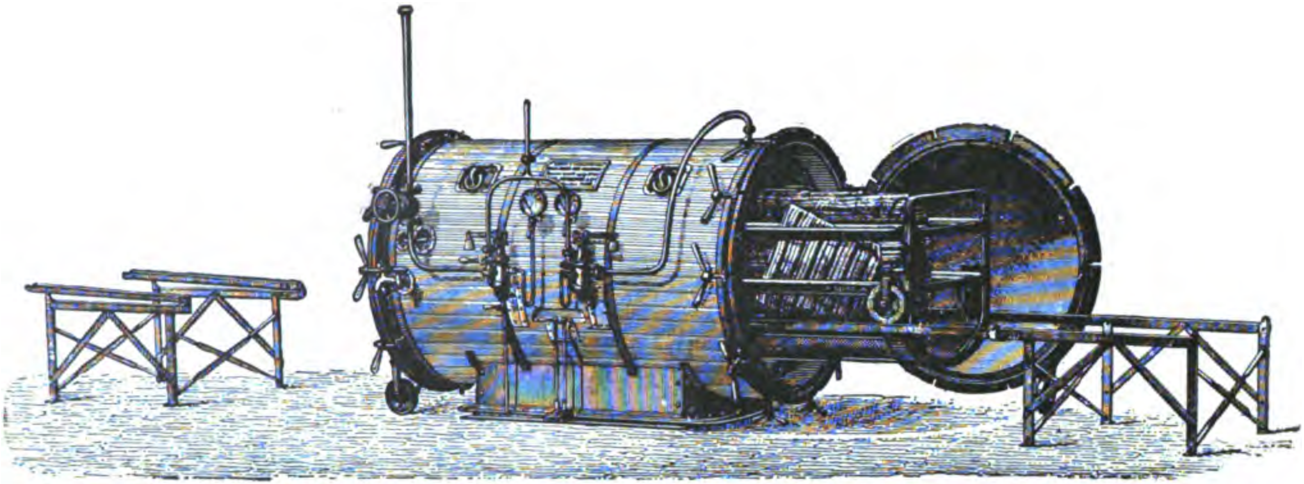


FIG. 35.—NEAR VIEW OF DISINFECTING CHAMBER AT BERLIN.

Articles to be disinfected by steam include clothes, linen, blankets, towels, carpets, curtains, mattresses and pillows, litters, etc. If the linen articles are soiled or stained, other methods should be used, as steam will fix the stain. Such articles may be first disinfected in a solution of corrosive sublimate and salt, and, after rinsing, sent to the laundry.

Leather and rubber articles also cannot be steamed, but should be soaked in a carbolic solution and afterward washed.

Boiling for fifteen to thirty minutes destroys noxious germs, and this is a most practical method for the household of applying moist heat. Infected articles, however, should be disinfected before sending to the laundry, or if washed in the house should be removed from the sick-room in wet bags and thrown with the bags directly into the boiler, to be boiled for twenty minutes before they are allowed to come in contact with the hands of the laundress.

Table of the Thermal Death-point in a Moist Medium of certain Pathogenia Bacteria. Compiled by R. G. FREEMAN.

SPECIES.	EXPOSURES.	OBSERVERS.
Spirillum Chol. Asiat.	52° C. for 4 minutes,	Sternberg.
Streptoccus pyogenes..	52°–54° C. 10 "	Sternberg.
Bacillus typhosus	56° C. 10 "	Sternberg.
Bacillus diphtheriæ.. .	58° C. 10 "	Welch and Abbott.
Bacillus coli communis	60° C. 10 "	Sternberg.
Pneumococcus.......	56° C.	Sternberg.
Bacillus tuburculosis...	from 55° C. and a few seconds to 80° C. for 1 minute.	Various observers.

DISINFECTION BY CHEMICALS.

Although chemical agents have long been known little definite concerning their efficacy was understood until laboratory experiments by Koch and others were made with them to test their effect upon bacteria. The severest test known is the destruction of the anthrax spore, this being the most resistant of all organisms. The method pursued by Koch was to soak threads in cultures of the spores of anthrax and other bacteria, and to place these, after they were dried, in disinfectant solutions of known strength, for known periods of time. After this expiration of time experiments were made to test the vitality of the bacteria. The following solutions only were found to have destroyed the activity of anthrax spores within a single day:

Mercuric chloride,	1 per cent. solution.
Carbolic acid,	5 " " " (not in all cases.)
Potassic permanganate,	5 per cent. solution.
Bromine water,	2 " " "
Osemic acid,	1 " " "

Since that time other chemicals have been experimentally proved to belong to the class of disinfectants proper, notably lime in various proportions.

The best and most convenient chemical disinfectants are corrosive sublimate, carbolic acid, milk of lime, chloride of lime. Sulphur is also used, burned in the room, for the generation of sulphurous acid gas, which,

when it comes in contact with oxygen, forms sulphuric acid, this latter being the effective agent in the disinfection. Each of these chemicals has its rather special field of usefulness.

Corrosive sublimate is used in solutions of 1 to 500, 1 to 1,000, 1 to 2,000. It is useful for disinfection of clothing, washing of walls, paint, and to wash the skin before a surgical operation, also for dead bodies requiring disinfection.

It is precipitated by albuminous substances, and therefore rendered inert in proportion to the amount of the latter with which it comes in contact. It is, however, redissolved in an excess of albuminous liquid, and is efficient where it penetrates the substance in question. On account of these qualities, however, it is not useful for disinfection of fæces, sputum and other organic matter. The addition of common salt to the sublimate in proportion of 5 to 1 prevents the coagulation mentioned.

Corrosive sublimate injures metallic surfaces, and is, therefore, not useful for disinfection of instruments.

Carbolic acid is used in 3 and 5 per cent. solutions. It is more generally useful than corrosive sublimate, as it is not readily decomposed, and does not attack instruments. Its odor is a danger-signal and is likely to prevent accidents.

Crude carbolic acid with equal volume of sulphuric acid filtered, is said to be more effective for excreta

than pure carbolic. This solution must be kept artificially cool.

Milk of lime is the most valuable agent for the disinfection of typhoid and cholera stools, as it is perfectly effectual, and has the great merit for the sick-room of being non-odorous. It is prepared by freshly slaking lime in a stone jar or wooden trough, and then adding to it four parts of water, forming the milk of lime. A quart of this solution may be added to each discharge. A proof of its efficiency is to test the mixture with litmus paper for a strong alkaline reaction.

Unslaked lime added to discharges is not equally efficacious, as the pieces of lime dissolve slowly, and their action is weak and uneven.

Chloride of lime is excellent for the contents of privies or foul closets. Six ounces to the gallon of water is the standard solution. (Sternberg.)

Sulphur. Three pounds to one thousand cubic feet of space are required. The room must be tightly closed, and the sulphur, moistened with alcohol, is set in an old pan, the latter being placed on bricks in a vessel containing water, to avoid the chance of fire. Fig. 36 shows such an improvised contrivance, where *P* represents the iron pan standing on bricks, *B*, in a large tub which holds a little water.

The Disinfection of the Sick-room. The daily dusting and cleansing should be done by cloths moistened in corrosive sublimate solution (1 to 1,000).

It is premised that all woolen curtains, carpets,

rugs and upholstered furniture have been removed before the infectious case entered.

Floors can be wipėd off with cloths wet as above. A sheet wet with carbolic solution may be hung before the door. All excreta are to be received into vessels

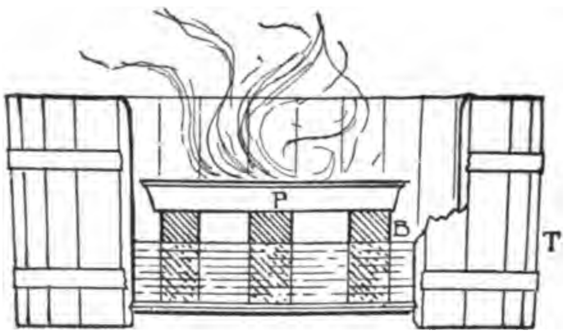


FIG. 36. HOUSEHOLD CONTRIVANCE FOR BURNING SULPHUR. *T*, TUB. *B*, BRICKS, *P*, SHALLOW PAN FOR HOLDING SULPHUR.

containing milk of lime, and the vessel should be covered before removed for emptying. Bed and body linen are to be thrown into tubs containing the carbolic solution (5 per cent.) or corrosive sublimate (1 to 2,000) and should remain there for six hours. Or they may be placed in bags and carried at once to the laundry, where they must be placed (without emptying bags) in boiling water, as described in paragraph on disinfection by steam and boiling.

All eating and drinking utensils should be washed in boiling water with a little soda.

Mattresses and pillows should be preserved from infectious discharges by rubber sheets.

The body of the patient should be kept scrupulously clean, and, in cases of diphtheria, the mouth and nose should be washed out with weak disinfectant solutions several times daily.

Convalescence having occurred, the patient should take a warm bath with soft-soap and water, his hair and beard should be thoroughly washed and preferably disinfected with the bichloride solution, and he should be dressed in fresh clothing. This process may well be repeated the next day before allowing him to mingle with other persons.

The room should be immediately closed, and not disturbed for at least six hours, to allow the dust to settle.

Disinfection may be begun by burning sulphur as described. Twenty-four hours later the cleaners, dressed in canvas or rubber gowns, and preferably wearing respirators, should enter and wipe off all dust from doors and windows with cloths moistened with bichloride solution.

The walls if painted in oil may also be wiped down with the same. If papered, they may be rubbed with glutinous brown bread for a height of six feet or more. Any adherent bacteria are caught on the glutinous surface and enveloped in the bread pellet. The crumbs are then to be swept up from the floor and burned.

All furniture should be wiped off with the damp cloth, wet in disinfectants, and, if heavily upholstered, should if possible be steamed or brushed well with a brush wet with carbolic solution. Finally, the floor should be mopped with the same or with the corrosive sublimate solution, and the room well aired before occupancy.

In cases of scarlet-fever and small-pox, it would be best to scrape the walls, if papered, and, after washing them down with sublimate, repaper them and paint the wood-work.

The Care of the Dead may be referred to in this connection, both as regards immediate attention and also the interment.

In case of death from contagious disease the body should be wrapped in a sheet wet with the bichloride solution, and the face covered with a cloth wet with the same. The strength of the solution should be at least one to five hundred. The body should not be removed from the room until it is to be interred. No persons should enter the room except the attendant who performs the services mentioned, and all articles used in rendering these services should be left in the room to be subjected to the treatment already described under disinfection of the sick-room.

No public or private funeral should be held in these cases, as the gathering together of a large body of persons in a house where such disease has occurred is attended with great danger of spreading the infection.

The interment should take place as soon after death as possible, consistent with decency.

The general custom is to require the use of an air-tight coffin in these cases, but if the body is well wrapped in disinfectant cloths, or in absorbent cotton, it would seem that the ordinary wood coffin or casket would be preferable, inasmuch as the air-tight coffins delay decomposition, and the consequent disinfecting action of the soil, which is nature's provision against harm from such sources.

There is at present a great deal of discussion as to the proper method for the final disposal of dead bodies, the two methods in question being that by burial in the earth, and that by cremation, and eminent authority speaks on both sides.

The objections to burial in the soil are, briefly, the possible contamination of air and water from the products of decomposition in cemeteries, and the danger of the spread of infection through these means. Cremation necessarily obviates these dangers. It would appear that burial in the earth is not necessarily accompanied by these dangers if certain regulations regarding the depth of the grave (*i.e.* the amount of soil covering the body) and the distance of the cemetery from habitations be observed. The products of decomposition are in time oxygenated, and rendered harmless by bacterial activity in the soil, if this is not overcrowded with dead bodies.

Vaults and built tombs should not be allowed, since

they interfere with this decomposition. Bodies should be buried at least five feet under ground.

Cemeteries should not be allowed in the neighborhood of towns. The soil should be dry, permeable, and drained, the drainage in no case being allowed to enter a stream used for domestic purposes.

The minimum allowance of space proposed for cemeteries is about a quarter of an acre per 1,000 inhabitants (Lowndes). Burials should not take place within fifteen to twenty feet of the cemetery boundary. With these precautions it would appear that burial in the earth might be permitted if desired.

The incineration of bodies is conducted in a crematory similar to that already described, and has been practiced considerably in England and somewhat in America during the last fifteen years.

ISOLATION—SEGREGATION—QUARANTINE.

By these means persons who have contagious diseases or who are suspected of having them, are prevented, in the incubative period, from coming in contact with others until the danger of spreading the infection is over.

Isolation is the term generally used in the household where a single patient and his attendant are confined to one room. In hospitals it is practiced on a larger scale by providing a separate ward or wards for such patients. In cities a separate hospital may be provided.

Segregation is isolation practiced on a larger scale, as where colonies of lepers are confined to one locality.

Quarantine is the isolation by government of large numbers of people (ship or car-loads) who have been exposed to infectious communicable diseases, and who are supposed to be capable of transmitting these to others by some of the methods already referred to. Originally the word indicated the forty days which were believed to be necessary for the incubation and development of the disease in inspected persons. The term has no longer any such significance.

"By quarantine is meant the adoption of restrictive measures to prevent the introduction of diseases from one country or locality into another" (Wyman). These measures may be adopted in regard to vessels and carried out in ports and stations, or they may be instituted on land in regard to travelers by rail or other inland communication. Hence we may have Maritime and Inland Quarantine.

The measures employed in general include the inspection of passengers by physicians, the separation of sick from well, the disinfection of their clothing and person, and of the ship or other conveyance in which they have journeyed, and the detention of the sick or suspected persons for a period of time that covers that of the disease in question; the latter detention to be maintained under sanitary surveillance of the strictest as well as most humane order.

To make such a system possible and effective, a

quarantine plant is necessary. The general requirements for such a plant are: (1) A boarding-station, on which the health officer and deputies reside; (2) a boarding boat, preferably a steamer; (3) an anchorage; this is the place of detention of the infected vessel; it should be remote from the line of commerce and sheltered; (4) a fumigation steamer; (5) a wharf; (6) a lazaretto or hospital for treatment of contagious diseases; (7) a hospital for treatment of non-contagious diseases; (8) barracks or other good accommodations for the detention of persons who have been exposed to contagion or infection.

The quarantine plant of the port of New York has its boarding-station at Clifton, Staten Island, where the health officers reside. It is here that the yellow flag is displayed, which may be seen by incoming steamers as they pass Fort Wadsworth. All vessels anchor opposite the boarding-station for inspection, which is required to be made by daylight. During an epidemic, however, they must anchor further down the channel. Hoffman Island is the detention island for suspects, two miles below the boarding-station. Here are dormitories and the special appliances for disinfection. The hospital island is Swinburne Island, about the same distance as Hoffman from Staten Island. Besides the wards for the sick there are disinfecting chambers, a crematory for the incineration of bodies dying of contagious diseases, a post-mortem room, and other appliances.

CHAPTER XX.

A Brief Account of the Cause and Prevention of the Principal Infectious Diseases.

The cause of each disease, so far as known, is given, and the prevention briefly discussed in each particular case.

Anthrax, due to the entrance of the *Bacillus Anthracis* into the body, is an epidemic disease common in sheep and cattle, and is most frequently communicated to men engaged in skinning carcases, sorting wool, or like occupation. When general, the bacillus is found in the blood and other fluids of the patient. It may be communicated by infected bandages or other articles on which the blood has dried, or it may be carried by insects who have fed on the dead infected animals, or through eating the smoked flesh of such animals, the bacillus having been preserved in the spore state. From flesh secretions the bacilli are easily destroyed by carbolic acid or boiling water, but in spilled dried blood, they form spores, which are types of great resistance to germicides. They resist 5 per cent. of carbolic acid for 37 days, and corrosive sublimate 1:1000 for 24 hours, and, dried, may remain virulent for years.

Prevention. Infected animals should be burned in deep pits, covered with chloride of lime, or better, should be cremated. All bandages, etc., should be burned.

Cholera. Cause—*Spirillum Choleræ Asiaticæ.* Non-contagious, communicable disease. Is disseminated most often through water which has been contaminated with the bowel discharges of patients. Bed and body linen so contaminated are frequent sources of spreading the infection, as well as soiled hands, and through these, food. The spirillum is quickly killed by drying, therefore it does not remain virulent in the atmosphere. Experiments prove that it will die in two or three hours, or possibly less time, if dried in a thin layer, as in exposure to sunlight, but will live much longer in thick layers. In weak carbolic acid (½ per cent.) it dies in a few minutes.

Prevention. The dejecta must be immediately disinfected with milk of lime or with carbolic acid. All bed and body linen should be immersed as described, in a disinfectant solution before being carried away to the wash. Laundresses are very liable to the disease, owing to a lack of care in these details. All water should be boiled during an epidemic, and all dishes and silver washed in boiling water. All disorders of digestion should have prompt attention. Sunlight and fresh air should be freely admitted to the sick-room.

Diphtheria. Cause — *Bacillus Diphtheriæ.* The infection generally spreads through the bacilli in the

sputa, false membranes and secretions of the nose and other diseased mucous membranes which may be coughed up.

The bacilli resist drying, and therefore may be scattered in the form of dust.

When dry they retain their virulence for fourteen days; moist, as in clothing or damp places, from four to seven months.

A temperature of 58° C. (136° F.) kills them in ten minutes. If present in dairies they may be disseminated through milk, which is an excellent medium for their cultivation.

Prevention. Isolation, complete, as long as a trace of the membrane remains, with the strictest disinfection of sputa discharges, bedding, dishes, hands of attendant, and the other matters in the room according to principles laid down.

Children should be kept from school at least four weeks after the disease has disappeared. Healthy children in the same house should have their throats sprayed several times daily with a disinfectant solution, as sublimate 1 to 10,000, or alcohol.

The question of prompt diagnosis in these cases is of first importance from the standpoint not only of treatment, but of prevention of further spread of the disease. Certain pseudo-membranous inflammations of the throat often occur which closely resemble diphtheria and in which the differential diagnosis is difficult —and the converse is equally true.

Recognizing the importance of these facts in their bearing upon the spread of the disease, the New York Board of Health has now taken measures by which any physician attending such a doubtful case may have a diagnosis made for him by the department of bacteriology and disinfection, through a bacterial culture from the case.

The materials for making the inoculations are to be obtained free from various druggists, the inoculation is made from the membrane, and the tubes returned to the Health Department through the druggist. The report and diagnosis are sent by noon of the following day, and the preventive measures vary accordingly.

Malaria. Cause—*Plasmodium Malariæ.* Not communicable. The manner of invasion is not known. The malarial agent seems most active in low, marshy regions, generally combined with heat. The disease is most prevalent in autumn, especially after dry and hot summers. The water of malarial regions is believed to be capable of transmitting the plasmodium.

Prevention. Persons in such districts should avoid exposure at night-time; elevation from the ground, as also the planting of trees are believed to have some preventive influence. In highly malarious regions Osler recommends boiling the water. Ten grains of quinine night and morning may be used, when exposed, smaller doses being sufficient in less malarious regions.

Pneumonia. Cause—*Diplococcus Pneumoniæ.* The organisms vary in virulence, and all persons do not

appear to be susceptible, but records indicate it may become epidemic in barracks under favorable circumstances. The sputa of pneumonic patients should therefore be treated as infectious material, and free ventilation and exacting cleanliness be maintained in the sick-room.

Puerperal Fever. Cause—*Various Pyogenic Bacteria.* Generally spread by soiled hands of physicians, midwives or nurses, or by infected instruments. The organisms resist drying and may be spread in dust, etc.

Prevention. Physicians attending labor cases should avoid attending infectious diseases at the same time, such as erysipelas, scarlatina, etc., and observe the rules laid down for disinfection of hands and instruments. Perfect cleanliness as to clothing, bed-linen, instruments, etc., should be observed. Where a case is suspected, the patient should be isolated.

Small-pox. Cause unknown. Contagious. The infection is spread through products of the diseased skin, from sputa, nasal secretions, etc. Is extremely tenacious, withstands drying, and floating in the air as dust may probably cause infection by inhalation.

The infectious agent retains its vitality for two years, occasionally longer.

Prevention. Complete isolation, with use of the means for preventing its spread—described under Disinfection.

Vaccination should be practiced at once in the case

of exposed individuals who have not been vaccinated within five years. Even when practiced after exposure it will mitigate, if it does not prevent, the attack. The spread of the infectious element is partially prevented by oiling the skin of the patient with vaseline.

Scarlet-fever. Cause unknown. Contagious. Agent is extremely tenacious, is probably most infectious during stage of desquamation. Is spread in same manner as small-pox—clothing and children's toys, books, etc., being very common means of carrying the infection. The infectious agent may remain virulent for five months, possibly longer. One attack usually affords immunity for a number of years.

Prevention. Is the same as in small-pox. Desquamation lasts from ten to fifteen or twenty days, and may continue for weeks.

Hospitals for the persons suspected of being infected and convalescent hospitals for those recovering are to be recommended.

Measles. Cause unknown. Spread in the same manner as the above. The agent, however, is less tenacious, more volatile, and therefore thorough ventilation and cleaning of the room after removal of the patient is sufficient. Clothing, etc., should, however, be disinfected.

Erysipelas. Cause — *Streptococcus Erysipelatos.* Easily communicated, resists drying. Killed by moist heat at 54° C. in ten minutes.

Prevention. Complete isolation of patient and dis-

infection of all articles, as well as hands, clothing, etc., of physicians and nurses, and whitewashing of walls of rooms after disinfection.

Tuberculosis. Cause—*Bacillus Tuberculosis.* Communicable, non-contagious. The bacilli are present in the sputa of patients in immense numbers; many millions may be expectorated daily. This (the sputa) is the great medium of communication to others, owing to the drying of the sputa, and its pulverization on the floors of street cars, boats, rooms, carpets, whence it is ground up and blown about in the dust of the air, and is inhaled or swallowed.

The bacillus may also be present in the discharges of patients having tuberculosis of the bowels.

Invasion through the lung is the principal method of acquiring the disease, but it may also be acquired through the stomach, by eating meat or drinking milk from tuberculous animals. Infection may also occur from putting coins, musical instruments, spoons and other articles which have been handled by tuberculous patients, into the mouth.

In the presence of the bacillus all conditions which lower the general health may predispose to the disease.

The bacilli remain virulent for five months in dried sputum.

Prevention resolves itself mainly into care of the sputum, as this is the great medium for the spread of the disease. This should be received into sputa cups whenever possible. These are now made both in

paper and in china, and should have a cover to prevent drying of the sputa and its dissemination in the air. They are sold at drug stores, and are very inexpensive.

A little water should invariably be used in the china cups to prevent drying of the sputa.

The contents may well be burned. If thrown into water closets, a few drops of carbolic acid (5 per cent.) may be used previously in the cup. Paper cups are to be burned.

China cups should be thoroughly washed with boiling water and soda.

Handkerchiefs should not be used for sputa, but if they become contaminated they must be thrown at once into boiling water and rendered sterile before they are handled any further.

Carbolic acid is preferable to other disinfectants.

The eating utensils of tuberculous patients should be boiled after using.

Kissing is to be avoided. Healthy persons should not sleep in the same bed with tuberculous patients.

Prevention in regard to tuberculous cattle has already been mentioned. Tuberculous individuals should not be engaged in dairies.

Persons predisposed to this disease should, as far as possible, avoid close association with those who have it. In the case of children so predisposed stress should be laid upon the development of the physique to its highest degree of perfection, through exercise, out-of-door life and a highly nutritious diet.

Long confinement at desks, and attendance at schools where anything but the best hygienic conditions prevail, should be forbidden.

The choice of occupation for life should preferably be in the direction of out-of-door employments when practicable; that of the counting-room, with its close confinement and generally bad air, being especially undesirable.

Limitation of the disease on a large scale by education of the public as to its cause and method of prevention has already been referred to, and the circulars of the New York Board of Health containing such information are appended in this volume as being suggestive of the scope of such literature.

Typhoid-fever. Cause—*Bacillus Typhi Abdominalis.* Non-contagious, communicable.

The bacilli are present in and distributed through the media of dejecta of patient, which may contaminate drinking water, and through that means may also get into milk supplies. They are rarely in air, but may adhere to walls of barracks, hospitals, etc.; remain alive several months in water-supplies, and resist drying for over three months. Are also relatively resistant to carbolic acid. Freezing is not necessarily fatal to them, therefore they may be found in ice cut from sewage-contaminated water, as already mentioned under Water.

Prevention. All water should be boiled in a locality where the disease prevails, and ice from any sewage-

contaminated water be forbidden. All dejecta of typhoid-fever patients should first be disinfected before thrown into sewers, or, in the country, are better burned. If thoroughly disinfected, they may be buried in regions remote from water supply. The body of the patient and hands of attendant should be constantly disinfected with a solution of three per cent. carbolic acid, and scrupulous attention paid to the details for disinfecting the discharges, bed and body linen, etc., as described.

In *Varicella*, *Typhus*, *Yellow-fever* and *Rubella*, the cause is unknown. Isolation in every case is to be practiced with strict disinfection. Typhus cases in an epidemic are well isolated in tents. The disease is always more prevalent in dirty regions. Yellow-fever spreads through *portable fomites* and atmospheric agencies—probably not by water. A slight elevation appears to have some limiting influence. Is not contagious.

Syphilis. Cause unknown. Is spread through the various secretions coming in contact with abraided mucous membranes or skin. It is believed that about 25 per cent. of all cases occurring in females are innocently acquired, mainly from articles used by syphilitic subjects; spoons, knives, forks, cups, glasses, wearing apparel, sponges, combs, pins, tooth-brushes, etc. In infants, in addition to the direct transmission from the nurse, it may be communicated by milk-bottles, cups, spoons, etc. Physicians and nurses may acquire

the disease in discharging professional duties, and may transmit it to other patients directly or indirectly by using contaminated instruments, etc.

As regards prevention, the avoidance of the use of the articles mentioned, in traveling, at stations, etc., will suggest itself.

The medical supervision of prostitution, especially in barrack towns, has been suggested, and practiced somewhat largely, especially abroad; but unbiased inquiry shows that this has entirely failed to effect the purpose.

Regarding marriage, it is agreed that at least two full years should elapse between the date of infection and the contracting of marriage, and at least one full year of immunity from all signs of the disease.

Suppuration, *Septicæmia* and *Pyæmia*. Cause—Various bacteria, such as *pyogenic streptococci*, the *staphyloccus pyogenes aureus*, and others. Spread through the secretions from wounds, abscesses, and similar processes, which may adhere to hands, instruments, etc. They may retain their vitality, dry or moist, for one year or longer. They float in the dust.

Antisepsis in the operating room is the great preventive, by which process, all instruments, bandages, clothing, tables, and especially the hands of the operator, which are particularly liable to be the cause of the infection, are made sterile by steam, dry heat and chemicals, respectively, by methods already described. All contaminated bandages should be burned.

COPY OF CIRCULAR OF INFORMATION TO PHYSICIANS REGARDING THE MEASURES ADOPTED BY THE BOARD OF HEALTH FOR THE PREVENTION OF TUBERCULOSIS IN THE CITY OF NEW YORK.

HEALTH DEPARTMENT,
No. 301 MOTT STREET,
NEW YORK, February 13, 1894.

The communicability of pulmonary tuberculosis has been so thoroughly established, and is now so generally recognized by the medical profession throughout the world, that the Board of Health of New York City has determined that the time has arrived when active steps should be taken, looking towards its prevention in this city. The Board has therefore resolved to adopt the following preliminary measures:

First—The Department will hereafter register the name, address, sex and age of every person suffering from tuberculosis in this city, so far as such information can be obtained, and respectfully request that hereafter all physicians forward such information on the postal cards ordinarily employed for reporting cases of contagious disease. This information will be solely for the use of the Department, and in no case will visits be made to such person by the inspectors of the Depart-

ment, nor will the Department assume any sanitary surveillance of such patients, unless the person resides in a tenement-house, boarding-house, or hotel, or unless the attending physician requests that an inspection of the premises be made; and in no case where the person resides in a tenement-house, boarding-house or hotel will any action be taken if the physician requests that no visits be made by inspectors, and is willing himself to deliver circulars of information, or furnish such equivalent information as is required to prevent the communication of the disease to others.

Second—Where the Department obtains knowledge of the existence of cases of pulmonary consumption residing in tenement-houses, boarding-houses or hotels (unless the case has been reported by a physician, and he requests that no visits be made) inspectors will visit the premises and family, will leave circulars of information, and instruct the person suffering from consumption and the family as to the measures which should be taken to guard against the spread of the disease, and, if it is considered necessary, will make such recommendations for the cleansing or renovation of the apartment as may be required to render it free from infectious matter.

Third—In all cases where it comes to the knowledge of the Department that premises which have been occupied by a consumptive have been vacated by death or removal, an inspector will visit the premises and direct the removal of infected articles, such as car-

pets, rugs, bedding, etc., for disinfection, and will make such written recommendations to the Board as to the cleansing and renovation of the apartment as may be required. An order embodying these recommendations will then be issued to the owner of the premises, and compliance with this order will be enforced. No other persons than those there residing at the time will be allowed to occupy such apartments until the order of the Board has been complied with. Infected articles, such as carpets, rugs, etc., will be removed by the Department, disinfected and returned, without charge to the owner.

Fourth—For the prevention and treatment of pulmonary tuberculosis it becomes of vital importance that a positive diagnosis shall be made at the earliest possible moment; and that the value of bacteriological examinations of the sputa for this purpose may be at the service of physicians in all cases not under treatment in hospitals, the Department is prepared to make such bacteriological examinations for diagnosis, if samples of the sputa, freshly discharged, are furnished in clean, wide-necked, stoppered bottles, accompanied by the name, age, sex and address of the patient, duration of the disease, and the name and address of the attending physician. Bottles for collecting such sputa, with blank forms to be filled in, can be obtained at any of the drug-stores now used as stations for the distribution and collection of serum tubes for diphtheria cultures. After the sputum has been ob-

tained, if the bottle, with the accompanying slip filled out, is left at any one of these stations, it will be collected by the Department, examined microscopically, and a report of the examination forwarded to the attending physician free of charge.

Fifth—The authorities of all public institutions, such as hospitals, dispensaries, asylums, prisons, homes, etc., will be required to furnish to the Department the name, sex, age, occupation and last address of every consumptive coming under observation within seven days of such time.

It is the earnest wish of the Board of Health that all practicing physicians in this city co-operate with the Board in an earnest and determined effort to restrict the ravages of the most prevalent and formidable disease with which we have to deal.

By order of the Board of Health,

CHARLES G. WILSON, *President.*

EMMONS CLARK, *Secretary.*

Copy of a Circular of Information for Consumptives and Those Living with Them.

(Issued by the Board of Health of New York City.)

Health Department,
No. 301 Mott Street,
New York, February 13th, 1894.

Consumption is a disease which can be taken from others and is not simply caused by colds. A cold may make it easier to take the disease. It is usually caused by germs which enter the body with the air breathed. The matter which consumptives cough or spit up contains these germs in great numbers—frequently millions are discharged in a single day. This matter, spit upon the floor, wall or elsewhere, is apt to dry, become pulverized and float in the air as dust. The dust contains the germs, and thus they enter the body with the air breathed. The breath of a consumptive does not contain the germs and will not produce the disease. A well person catches the disease from a consumptive only by in some way taking in the matter coughed up by the consumptive.

Consumption can often be cured if its nature is recognized early and proper means are taken for its

treatment. *In a majority of cases it is not a fatal disease.*

It is not dangerous for other persons to live with a consumptive, if the matter coughed up by the consumptive is at once destroyed. This matter should not be spit upon the floor, carpet, stove, wall or street, or anywhere except into a cup kept for that purpose. The cup should contain water, so that the matter may not dry, and should be emptied into the closet at least twice a day and carefully washed with hot water. Great care should be taken by a consumptive that his hands, face and clothing do not become soiled with the matter coughed up. If they do become soiled, they should be at once washed with hot soap-and-water. When consumptives are away from home, the matter coughed up may be received on cloths, which should be at once burned on returning home. If handkerchiefs are used (worthless cloths which can be burned are far better) they should be boiled in water by themselves before being washed.

It is better for a consumptive to sleep alone, and his bed-clothing and personal clothing should be boiled and washed separately from the clothing belonging to other people.

Whenever a person is thought to be suffering from consumption, the name and address should be sent at once to the Health Department, on a postal card, with a statement of this fact. A medical inspector from the Health Department will then call and examine the per-

son to see if he has consumption, providing he has no physician, and, if necessary, will give proper directions to prevent others from catching the disease.

Frequently a person suffering from consumption may not only do his usual work without giving the disease to others, but may also get well, if the matter coughed up is properly destroyed.

Rooms that have been occupied by consumptives should be thoroughly cleaned, scrubbed, whitewashed, painted or papered before they are again occupied. Carpets, rugs, bedding, etc., from rooms which have been occupied by consumptives, should be disinfected. The Health Department should be notified, when they will be sent for, disinfected and returned to the owner free of charge, or, if he so desires, they will be destroyed.

By order of the Board of Health,

CHARLES G. WILSON, *President.*

EMMONS CLARK, *Secretary.*

INDEX.